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EDITORIAL ANNOUNCEMENTS.

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CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

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VOL. XLI., No. 22. FRIDAY, NOVEMBER 30, 1906.

Mr. Alfred Akerman, State Forester of Massachusetts, is the author of an interesting document (Bulletin No. 5 of the State Forest Service) concerning forest fires. His discussion is always rational and interesting. He states the causes of forest fires to be numerous and to include matches, cigar stumps, camp fires, bonfires, brush burning and locomotives. Of these he finds brush burning and locomotives most deserving of special notice. Farmers are the chief offenders in the careless burning of brush and rubbish. The number of fires set by railroads is greater than from any other single known cause. Fires may be set by workmen in burning ties or rubbish along the right of way, or by coals dropped from ash pans of locomotives, or by sparks from locomotive stacks. Fires set by workmen or by coals from ash pans are invariably the result of pure carelessness. He thinks there is no excuse for either. Mr. Akerman admits, however, that the setting of fires by sparks from locomotives is a complicated matter. Unlike most writers of such reports he is refreshing in his understanding of the conditions under which a locomotive must be operated. He admits that a normal locomotive cannot do the work for which it has been designed without the possibility of emitting sparks, a statement, the frankness of which coming as it does from a state forester, is significant. After such a statement, the railroad officials of Massachusetts may well bow to their forester when he urges the desirability of frequent and careful inspection of the front end of the locomotive and the removal of inflammable material for a distance of 50 ft. from the center of the track. An interesting deduction to be made from the facts presented by the report, and which, by the way, is not suggested by the Forester, though it stands in full view upon the face of his figures, is to the effect that while the railroads are responsible for a portion only of the whole number of fires set, presumably for less than half, they apparently pay for the damage done by all. The records, unfortunately, are in such shape that a strict comparison of damage and payments can only be made for the year 1904. In that year the estimated value of timber or wood, cut or growing, which was destroyed in the State of Massachusetts by forest fires arising from all causes, is placed by the state census report at $14,764. But the amounts paid in Massachusetts by railroads, in settlement of damages from forest fires alleged to have been set by locomotives during the same year was as follows:

Boston & Albany, year ended Nov. 1, 1904.....	$4,699
Boston & Maine, year ended Dec. 31, 1904.....	19,426
New York, New Haven & Hartford, year ended June 30, 1904.....	19,395
	$43,520

The census year ends December 31. Two of the railroads in the list give returns from fiscal years ending at other periods, and the objection may be made that their damages were incurred, partly or entirely, in the previous calendar year. But even if the sums paid by the New Haven and the Boston & Albany be excluded entirely, it will be seen that the Boston & Maine paid damages some 30 per cent. in excess of the estimated total. For 1903 and 1904 together, the Boston & Maine paid $54,285, and the two other roads (using the figures of their respective 1904 fiscal years only) paid $24,094, a total of $78,379. This excludes payments by the New Haven from January 1 to June 30, 1903, and from June 30 to December 31, 1904, and payments by the Boston & Albany from January 1 to November 1, 1903, and from November 1 to December 31, 1904, yet the incomplete total is 120 per cent. greater than the actual damage as estimated by the census bureau. Evidently the careless farmer does not even pay for the damages he occasions his own property. Indeed, forest fires at 120 per cent. profit to the owner of the timber seem more attractive, commercially, than the better-known industries of the state.

EARNINGS SINCE THE CLOSE OF THE FISCAL YEAR.

Earnings from most of the principal railroads in the country for the three months ending September 30, 1906, are now at hand, and afford an interesting study in the progress of events during the continuance of the great wave of prosperity. The table printed herewith gives the returns from 34 roads. All but one of these increased their gross earnings during the three months. The results in net were not quite so satisfactory, although the showing is not a bad one. Just half of the roads in the list give a smaller percentage of increase of net earnings than of gross, while five roads show decreases in net as compared with the same three months in 1905. If full returns for the month of September were

at hand, it would be seen that the net showed a very general tendency to fall off, especially in certain quarters, but returns for a single month are not of great value, being subject to many influences that do not necessarily affect the total for the year.

Percentages of Increase, Gross and Net—July 1 to Sept. 30, 1906.

	Gross.	Per cent. Inc.	Net.	Per cent. Inc.
A., T. & S. F.	$21,293,597	14	$8,255,803	21
A. C. L.	5,706,345	9½	1,166,823	23*
B. & O.	28,125,241	10	10,171,177	6
B. & M.	11,219,155	7½	3,353,434	2
C. P. R.	18,291,187	28	7,272,322	39
C. & O.	6,273,478	9	2,379,671	4
Alton	3,284,017	8	1,305,987	38
C. G. W.	2,468,709	12	823,792	13
Colo. & S.	3,223,893	12	967,729	9
D. & H.	3,675,538	11	1,643,273	21
D. & R. G.	5,313,463	7½	2,113,576	5
Erie	13,317,380	4	4,030,477	2*
Grand Trunk	8,656,529	8½	2,668,788	5
Hocking Valley	1,831,163	9	691,346	6
I. C.	13,475,940	15	3,711,102	20
L. S. & M. S.	11,177,682	11	2,245,131	24
L. V.	9,432,555	11	4,186,743	18
L. & N.	11,580,734	13	3,100,032	4
M. St. P. & S. S. M.	3,432,317	20	1,772,083	12
M. K. & T.	5,877,585	13	2,057,129	59
M. P.	12,155,506	9	4,063,955	12
N. C. & St. L.	2,804,494	10	611,080	½
N. Y. C. & St. L.	2,430,752	11	611,259	9
N. Y. N. H. & H.	14,299,619	3	5,372,047	1*
N. & W.	7,526,577	8	2,875,396	5
P. & R.	10,055,677	½*	3,943,045	9*
C. R. I. & P.	14,357,357	9	4,749,741	19
St. L. & S. F.	11,542,716	12½	4,010,347	16
St. L. S. W.	2,431,321	15	814,974	64
S. A. L.	3,546,138	3½	410,593	5½*
Southern Pac.	28,671,713	12	10,707,781	22
Southern Ry.	13,695,325	7	3,230,153	12
Union Pac.	18,913,650	8	9,206,111	9½
Wabash	7,202,702	12	2,470,271	17

*Decrease.

It is interesting to take up the three months' earnings somewhat in detail with a view to understanding their causes, although it is impossible to make a full analysis. It will be seen that the roads which have made the most striking record of increased growth are, first of all, the Canadian Pacific, with an increase of 28 per cent.; next the Minneapolis, St. Paul & Sault Ste. Marie, 20 per cent.; then the Illinois Central and the St. Louis Southwestern, 15 per cent., and the Atchison, 14 per cent. The greatest increase in net for the period was made by the St. Louis Southwestern, 64 per cent., but this showing is, in itself, scarcely a fair test of prosperity, since the road dragged along through 1905 with a succession of bad records, occasioned partly by its traffic conditions and by the quarantine, but chiefly by the fact that the trunk lines wanted cars and were not disposed to give the Cotton Belt its own or any of their own. Something the same thing is true of the Missouri, Kansas & Texas with its increase of 59 per cent. in net, yet the showing made by these two roads for the present quarter is unmistakably a very good one. The best showing in the entire list, from a standpoint both of gross and of net, is unquestionably the Canadian Pacific, which increased its net earnings 39 per cent. on top of an extraordinarily profitable quarter last year. There seems to be no limit to the possibilities of this road's achievements, and beside its large earnings from current sources, it has as an extremely valuable asset, its land grant holdings, worth, nobody knows how much, in view of the great development of the Northwest country. Other extremely good showings in net are made by the Alton, the Lake Shore, the Southern Pacific, the Illinois Central and the Delaware & Hudson. In addition to the Cotton Belt, the Missouri Pacific, Wabash and Denver & Rio Grande, constituting the other Gould roads on the list, also did well. The showing of the Denver & Rio Grande is the least conspicuous, chiefly for the reason that it had a good quarter in 1905, while the other roads had a very bad quarter. It is curious to see that two of the Southern roads covering, with their joint mileage, a vast extent of territory—the Atlantic Coast Line and the Seaboard Air Line—show considerable decreases in net, especially the Coast Line, which makes the worst net showing in the list. The position of the Atlantic Coast Line is partly due to the fact that the 1905 quarter was a very good one and partly due to increased operating expenses. In the case of the Seaboard, we strongly suspect that the under-maintenance which has characterized the property for years, is being corrected. The sums spent per mile of track and per locomotive and freight car have been clearly inadequate for several years, and there is much to be done out of earnings which the road's prosperous condition makes it profitable and advisable to do at the present time. It is unnecessary to take up in detail the criticisms of this property made by Mr. John Skelton Williams. Whether or not the car supply has been badly handled, there is need for more money to be spent, and the decrease in net is rather healthy than otherwise. The decrease on the Erie is disquieting, even though it amounts to only 2 per cent., for the reason that this road has more or less constant difficulty over the wage question, and is so situated that it will be harder for it to resist demand for increased pay by employees than it would if it were a little farther away from the other trunk lines. Mr. Underwood has brought this company success in the face of much adversity, but even small wage increases, apart from the general higher cost in materials prevailing, would be likely to prove quite an embarrassment.

It is probably safe to say that it lies within the power of every road on the list that has made a poor showing this quarter in net earnings to improve that showing (excepting perhaps the Erie and the Boston & Maine) by a curtailment of the expense account. It has always been true in seasons of great prosperity that expenses have tended to extravagance, because there was no obvious and stern need to keep them down. It will be recalled how this was limited three years ago, when there was a halt in increased earnings, by setting aside work which was not pressing and reducing forces. In spite of the tremendous amount of betterment work which is urgent and much of which should be paid for out of earnings it is distinctly possible to reduce the expenditures on this account whenever it may seem necessary to do so. The only increases of serious moment are those in wages, which can be increased very readily, but are not so easy to decrease when prosperity slackens its pace.

FUNDAMENTALS.

Personally, I am one of those who look with serious distrust on each extension of political activity. I believe that the Interstate Commerce law did more to prevent wise railroad regulation than any other event in the history of the country. I think that the courts would have dealt with our industrial problems better than they have done if the anti-trust act had never been passed. I have gravely doubted the wisdom of some of the more recent measures adopted by the national government. But I cannot shut my eyes to the fact that these things are what business men must expect unless business is somewhat modified to meet existing conditions. Industrial corporations grew up into power because they met the needs of the past. To stay in power, they must meet the needs of the present and arrange their ethics accordingly.—*A. T. Hadley.*

During an era of political excitement, in which corporations and all large vested interests constitute the center about which the storm is raging, it is refreshing to revert occasionally to fundamental principles. When the stockholders of the Standard Oil Company transferred the control of their property to trustees and created the first "trust," they sought to accomplish good, not evil; when the Northern Securities Company was formed, in an eastern state, to hold the stocks of certain railroads in western states which were parallel and which the law desired to make competitors, economy and lack of economic waste were the objects, not oppression. Yet to-day the Northern Securities Company exists only in memory, and the Standard Oil Company is fighting for its corporate life, while the very title "trust" has become a byword. After the decision of the courts in the Northern Securities case, we took occasion to make a list of the railroad properties which seemed equally culpable, or nearly so, as regards the harmony of management and operation which they represented in the case of parallel lines in the same territory. This list need not be reproduced; it is sufficient to say that it represented a tolerable portion of the entire mileage of the country. Then the government announced that it did not propose to "run amuck," suggesting the obvious comment that the stability of the principal commercial ventures of the United States rested rather on the whim of the Chief Executive and his legal department than on any assured basis guaranteed them by the government. In a nation where sovereignty was intended to be bounded quite sharply by state lines, and where business has come to be transacted almost wholly without regard to them, it is inevitable that friction should have resulted, and it is probably also inevitable that the central government should have taken authority over certain corporate acts and relations not amenable to the jurisdiction of any single state. But it is most unfortunate that the laws providing for these extensions of power are worded so loosely that their scope and meaning is no definite thing, but a variable, depending, in the last analysis, upon the composition of the United States Supreme Court and upon the individual beliefs of its members.

The facts as related are not new ones, but they bear new significance from the radical attitude of the present government towards corporate interests. What is the end to be? Dr. Hadley has hit the keynote of the present situation in the two points he makes; that corporations to stay in power must meet the needs of the present and arrange their ethics accordingly, and that exten-

sions of political activity are to be feared. On the one side are Harriman methods; on the other, a government about to place its chief prosecutor on the bench of the Supreme Court. Corporation ethics to-day are materially better than they were in the days of Jay Gould and Jim Fisk; better, even, than they were ten years ago, yet they are considerably short of perfection. But does the remedy for them lie in the tangled web of the anti-trust act? It is surely not in the interest of the consumer that kerosene should be sold at prices which would prevail without the great skill of the Standard Oil Company or some equally efficient organization directed towards reducing the cost of production, and the ultimate cost of railroad competition must always fall on the passenger and the shipper, as it has always fallen in the past. Does the government propose to abolish all forms of consolidation that tend to cheapen production, in the interest of the enterprises that are too small to produce cheaply? If so, why not make the political issue squarely on that ground! It is evident that every combination that is successful is in restraint of trade just so far as it succeeds in producing more cheaply than its small competitors can; is that the meaning of the anti-trust act?

These are all fundamentals, as is also the proposition that the national police power should be exercised to punish extortion and dishonesty, when such extortion and dishonesty come within its proper jurisdiction. They are worth keeping in mind at a time when the efforts of the government are directed at tearing down rather than at building up, and the Supreme Court, so far as this lies within the power of the Chief Executive, is to be lined up with the prosecutors.

WHEN THE FLAGMAN INSULTS THE SIGNALMAN.

The brief paper on the flagging rule which Mr. Slater, of the Southern Pacific, sprung on the Signal Association at Washington last month arrested the members' attention with great success. It was equal to a flag and a torpedo combined. True to the nature of flags and torpedoes, it came unexpectedly; and thereby illustrated the disadvantage which unexpected things labor under, as compared with things, such as fixed block signals and previously printed papers, that everybody is prepared for. The discussion had to be cut short for lack of time, and for that reason each member who spoke felt, no doubt, that the quality of his remarks was in inverse proportion to the importance of the subject. But it will be taken up at another meeting, and it is to be hoped that there will then be a strong representation of transportation officers present, for in discussing this subject the signal engineers are constantly restrained by the feeling that their superiors may think that the signal association is stepping outside of its proper field. It is a good thing, however, to have this question agitated in any field, so long as the agitators are well qualified to speak on it; and most of the signal engineers certainly are.

The inconsistencies and absurdities of our present practice are apparent to everybody who looks into the matter. The hodge-podge of block signaling, time-table, time interval, flagging, torpedoes and fusees is defended by nobody. On the most important through lines, with an equipment of block signals that is lauded in the road's advertisements as the best, passengers in sleeping cars are awakened in the middle of the night by the noise of the whistle of the engine calling in the flagman after a brief stop, and are thus constantly reminded of the imperfection or supposed imperfection of the block signals. Every superintendent who keeps watch of his brakemen and has occasion frequently to investigate the practice of his flagman and engineman labors constantly under the feeling that he is leaning on broken reeds—which he hopes to put together in bundles that shall be so large and so securely tied as to take the place of one sound staff. Every committee which has tried to frame a satisfactory flagging rule has failed; and the best flagging rules have served only to show the difficulty or impossibility of getting men who will intelligently and faithfully carry them out.

As a result of this condition, railroads everywhere are keeping up the inconsistent practice which Mr. Slater described in his paper. A flagman is required to go back as though there were no other protection for his train from rear collision. If he goes beyond a fixed block signal the discredit to that block signal is glaring. If he goes only to it and stops there, the question arises, Why should not the signalman in the tower (where the manual block system is used) go down to the ground and stand there with a flag every time that he puts his signal up behind a train? In the case of an automatic signal there is no tower there, and no signalman; for this reason the feeling that man-operated signals are superior to automatic still survives. It exists so generally that the Signal Association, following the discussion of Mr. Slater's paper, voted unanimously that man-operated signals were the only kind that could be trusted absolutely. Even these were declared to be fully trustworthy only when equipped with electrical lever-locking (from one station to another) and with apparatus by which each train shall always put the signals in the stop position behind itself regardless of any negligence on the part of the signalman.

Conditions like these, and others with which the reader is already thoroughly familiar, may well cause every railroad officer to join Mr. Slater in asking the question whether our automatic block signals are to be anything more than ornaments.

But we have the anomalous condition that we already do treat these signals as something more than ornaments. In committee meetings and public discussions we set up our theories of perfection and swear eternal allegiance to them, thus declaring the signals imperfect; but in practice we run trains so close together that the flagging rule is not likely to be of any service whatever as a protection, and therefore we do depend entirely on the block signals, whether we acknowledge the fact or not. In short, we are in the situation where the flagging rule is used as a buttress to the block system when and where it is convenient to use it, and is omitted where and when it is inconvenient or impossible to use it. The question where it shall be used and where it shall not, is decided by the general manager, the superintendent, the brakeman and the conductor on premises so mixed that nobody tries to formulate them. From this condition—and brakemen all the time learning by experience that flagging is unnecessary in millions (perhaps billions) of cases (where required by the rule) to one case where it will actually prevent a collision—we seem destined to slowly drift into that prevailing on the English railroads, where flagging is almost universally neglected and where the critical inspectors of the Board of Trade seem to be utterly oblivious to it as a protection from collision.

Whether we do or do not become more like England, the fact remains that we, like the English, have thousands of miles of road on which the block system is nearly perfect, and the question is whether we are going to bring it sufficiently near perfection to abandon definitely and officially the costly, inconsistent, annoying, discipline-destroying flagging rule. Without block signals the flagging rule is every superintendent's *bête noire*. With block signals it is liable to bring him into contempt.

Naturally it requires rare courage to make a change which cannot be warranted in advance to cure the collision disease absolutely, for everybody fears that the credit of any improvement effected by the change would be nullified by those collisions which should occur, howsoever much their frequency might be reduced. So difficult a problem must therefore be undertaken with caution; and Mr. Slater's proposition is in that respect commendable. He would take only one simple step. Where there is a block signal that protects a train with a half-mile overlap (the rear of the train having passed the signal half a mile) or more than half a mile, the brakeman, having seen the signal, and having put down his torpedoes at least a quarter mile back of the rear car, may return to his train. That would be a very conservative innovation. If the Southern Pacific superintendents refrained from recommending it because they had never heard of anyone else who did such a thing we advise them to reconsider their decision. Their conservatism is excessive. Whether the torpedoes half way between the train and the signal are worth what they cost—say five cents—may well be questioned. Logically the approval of this feature would lead to a demand for an automatic or man-controlled torpedo-placer at every home block signal.

Without regard to the torpedo, however, logic—or common sense—leads us to a second conclusion. If the brakeman's certificate that the block signal stands in the stop position is a sufficient protection to his train (with the torpedo 80 rods back) why should not he have observed the signal when he passed it, and thus be able to certify its position without going back to look at it? Then the train would not be delayed any longer in a three mile block than in a half mile block. If rear brakemen observed all signals and made a record of their position, the block system, as a system, would be perfect; for the conductor of a train could by referring to the brakeman's record at any time learn whether or not the last signal passed was left in the stop position.

The block system ought to be made perfect, for reasons already indicated and suggested. This idea of having rear brakemen know what kind of signals they have passed has been recognized, and

even put in practice to some little extent, but it still needs extensive testing. Is this not a question well worth settling? If brakemen cannot be disciplined so that they will bring in complete records every trip let us ask whether the discipline in that feature can be any more defective than it is now in respect to flagging. If there is a question as to the prompt filling up of the record immediately after the passage of the train past each signal, surprise checking is available as an antidote to carelessness. If signals are sometimes hidden by steam or smoke, so that brakemen must report frequently that the position of a signal is unknown, the only remedy may be to have some additional attachment or contact fixed to each signal; but would not that be worth trying? At all events there is no reason in leaving the matter of train protection in its present unsatisfactory condition while so apparently feasible and simple a safeguard has not been fully tested. That some man on a train ought to know that the last block signal passed by it was left in the stop position is a definite need. This need is recognized on some roads by fixing the signal post 200 ft. beyond the entrance to the block section, so that the engineman can see it turn to "stop" a moment before he passes it. On roads where this practice—on some grounds objectionable—is not in vogue, where the signal remains clear until the engine has passed it, the same need should be met by having some one else see that it moves or has moved to the stop position. The rear brakeman is the man who can best do this.

The New York Subway, with its overlaps and automatic stops, represents a definite attempt to make the block system perfect in itself and not dependent on the aid of flagmen. The New York Central's proposed signaling in its electric zone, with its long overlap, is another attempt in the same direction. Expressions here and there from expert railroad officers indicate apparently a growing approval of the principles on which the officers of these roads have acted. Some railroad officers who believe in the principles, take no action looking to their adoption on their own roads because of the real or supposed excessive cost of maintaining such safeguards. But if the principle is correct—the principle of making the block system as nearly perfect as it can be made—only the most complete evidence of imperfect results or extravagant cost can justify any passenger railroad in relaxing its efforts to attain the desired perfection.

One of the chief elements in the argument for the use of the block system is the need of providing a method of running trains under which the superintendent of the road can enjoy a reasonable freedom from anxiety. His peace of mind is a valuable asset of the company. The improvement here suggested is necessary to the accomplishment of that result. Mr. Slater has made what should prove a most fruitful suggestion.

October Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of October, printed in another column, contains accounts of 21 collisions, 23 derailments and 5 other accidents. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

	Place.	October.	Killed.	Injured.
1.	Lansingburg, N. Y.	4th	5	25
2.	Carondelet, Mo.	11th	4	10
3.	Whitefish, Wash.	14th	3	5
4.	Foraker, Okla.	22d	0	20
5.	Boutte, La.	22d	4	36
6.	Durbin, Ohio	27th	4	2
7.	Atlantic City, N. J.	28th	57	20

The first and the last accidents, Lansingburg and Atlantic City, are the only ones in this list which are out of the ordinary. The first one affords a striking example of a state commission quickly stirring to lock the door after the horse is stolen, and the other is equally notable as a case where the public is peculiarly interested in having a full and unprejudiced report of all the facts, but where there is no public authority to furnish anything of the kind. New Jersey has no competent investigating body, and the Federal Government investigates only by letter. It takes the report of any accident, even the most serious, about as the railroad company offers it. Such a report may be very insufficient, for even those railroad managers who will make an unprejudiced report—there are a few such—are quite likely to fall short in the other essential, fulness of detail. Once more the need of a strong governmental information bureau in this field is brought home to everybody's mind.

As to the facts of these cases, the New York Commission finds, according to the published accounts, that the engineman in the Lansingburg case had not enough distance to stop in. Whether or not this throws the whole blame on the preceding train's flagman is not clear, for we are not informed whether a safe time interval had been prescribed and maintained at frequent intervals north of Lansingburg. The remedy recommended is a second main track and automatic block signals, which illustrates the confusion of thought often seen in the state commission reports. How would a second track cure the disease of rear collisions? It would not. It would reduce congestion of course. But if removing congestion is the main thing to do in dealing with this danger, some roads are in a desperate case! In the Atlantic City case there seems to be no dissent from the conclusion of the coroner's jury as to the cause of the car jumping the track, though the railroad apparently still holds to its claim of "not proven." As intimated above, the need is for a full exposition of all the circumstances; the rail and its fastenings and locking apparatus; the floor of the bridge, the guard rails, their material size and situation, outside and in, and the signaling and interlocking. In the last big drawbridge disaster, that in Virginia a year ago, it appeared that there was no interlocking whatever. A well-posted railroad officer recently remarked that he knew of only one road which had approach locking (by track circuit) at its drawbridges. With facts like these before us, who dissents from the proposition to establish Government investigation?

The number of electric car accidents reported in the newspapers of the United States in the month of October was 207; 10 persons were killed and 191 injured. The worst accident in this list was one which occurred at Toledo on the evening of October 10, when a street car was struck at a crossing by a passenger train of the Cincinnati, Hamilton & Dayton. Fifteen persons were killed or injured, the deaths, according to the reports, numbering four.

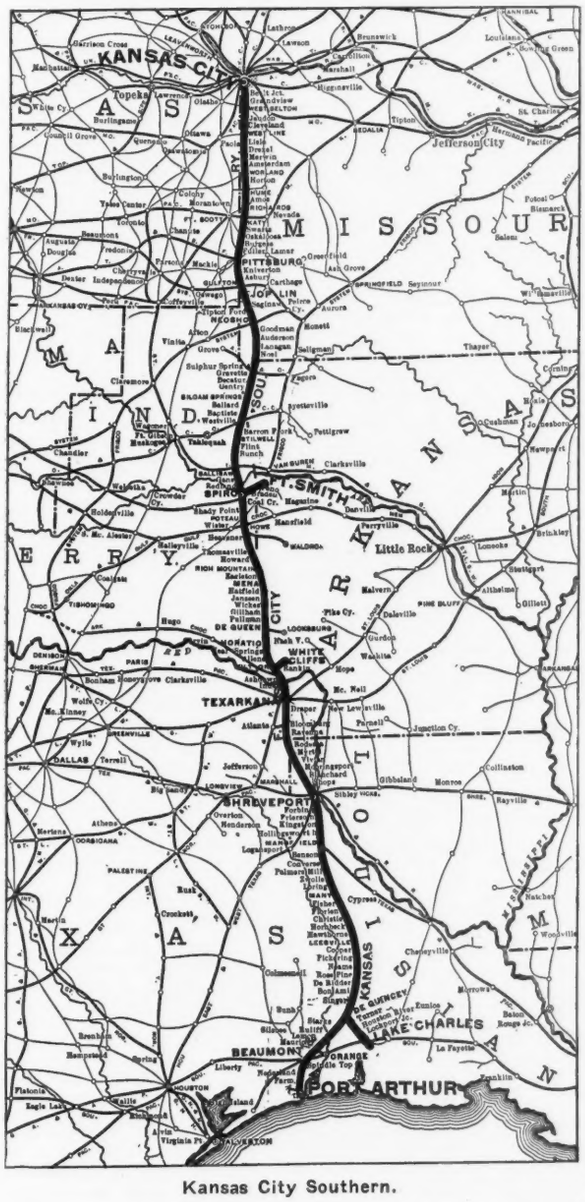
Kansas City Southern.

In 1897 the Kansas City, Pittsburg & Gulf was put in operation from Kansas City to the Gulf at Port Arthur, Texas. It was an independent road built under speculative methods, and it promptly began to make its influence felt among the railroads of the Southwest by sharp rate cutting. A period of severe competition in rates during which the road lowered its tariffs to a point which probably little more than covered direct expenses of operation, was followed in 1899 by the receivership of the property, which was reorganized in 1900 as the Kansas City Southern. For the first five years the road was operated under a voting trust of which E. H. Harriman was chairman, several general officers of the Harriman Lines being appointed to similar positions on the Kansas City Southern. A large share of the ownership of the road was held in Holland and the Dutch holders formed the nucleus of the independent stockholders, who, in May, 1905, took over the property from the voting trust and proceeded to reorganize the management and policies of the road.

The annual report of a year ago, covering the fiscal year ended June 30, 1905, is a severe arraignment of the management of the property under the voting trust. It must be remembered, however, in passing judgment on the previous control, that the road itself had scant funds available for maintaining the property, while, at the same time, it was by no means to the interest of many of the managers to lend their credit to obtain funds with which to build up the Kansas City Southern as a competitor to roads in which they were more directly interested. The road was found by the new officers to be in thoroughly bad shape, not only for economy in operation, but even for safety in carrying its regular traffic. Owing to bad conditions of roadbed and track, inadequate warehouses, yards, sidings, water stations and telegraph wires and insufficient number of locomotives and cars, a large proportion of which also were in bad repair. During the first six months of the calender year 1905 there were 715 wrecks and derailments important enough to cause serious loss and delay. Besides the destruction and damage to property thus caused, the delay to train service, with its resulting high expenses for extra fuel and overtime and the diversion of traffic, following the serious loss of confidence and good will of the public naturally gained under such a record of accidents, were serious losses to the road. The outbound freight house at Kansas City was an example of the poverty stricken condition of the property. This was a narrow open shed in poor repair with a small space at one end boxed in for the care of tools, contrasting with substantial modern warehouses owned by competing roads. Of the equipment, 25 per cent. of the locomotives were in bad order and from 35 per cent. to 50 per cent. of the freight cars required heavy repairs. Of the whole freight equipment 65 per cent. was unfit for use in transportation of freight which requires dry cars, such as grain and merchandise. Repairs had been improperly made with inferior materials, so that soon after being repaired cars were again in bad order. In a word, the road hastily built, with steep and frequent grades, insufficient cutting and ballasting and cheap construction in the first place, had been allowed to deteriorate to a point where operation was at once uneconomical and dangerous.

The Kansas City Southern has a main line 788 miles long

from Kansas City south to Port Arthur. Eleven miles of this near the Kansas City end are trackage rights over the St. Louis & San Francisco. The principal traffic of the road is raw materials, particularly lumber, originating in the center and on the southerly end of the line and destined for Kansas City and points beyond that gateway. It has a small return haul in grain and merchandise traffic south from Kansas City, much of which however instead of traversing the whole length of the line, leaves the road at Shreveport, La., to be carried to the Gulf at New Orleans by steamer on the Red and Mississippi rivers. It is particularly deficient in branch line mileage, having only 83 miles of feeders, of which the longest is a 32-mile branch operated separately by the Arkansas Western. It therefore has an unusually heavy freight density for a road in the Southwest, but most of its traffic is carried at low rates



Kansas City Southern.

and over expensive gradients. Grades of 1 per cent. or more are scattered over the 719 miles of line from Kansas City to DeQuincy, La., so that there is not a single low grade operating division on the road. For this reason, in spite of the heavy character of the traffic, the typical train carries only 15 loaded cars. The trainload is, therefore, only 289 tons of revenue and 327 tons of company freight, these figures being larger, one by 21 tons, the other by 38 tons, than in 1905. A thorough examination into the possibilities of grade reduction is now being made. This is one of the most important problems which is to be faced by the present management, as on account of the density of heavy traffic, a reduction of grades is necessary to efficient and economical operation.

The most fundamentally important step taken by the present owners, on assuming control, was the securing of new capital for improvements. Twenty-year improvement 4½ per cent. bonds to the amount of $10,000,000 were authorized on March 19, 1906. Of these, $6,000,000 were pledged as security for an issue of $5,100,000 5 per cent. six-year notes. Of the proceeds of this note issue, about $2,200,000 has since been used in general improvements to the property. New equipment has been obtained under two equipment trusts of a total issue of about $2,000,000. Some 60 spur tracks have been or are being built or extended to better serve industries previously on the line. At the same time ordinary maintenance under operating expenses has been liberally charged against earnings.

The cost of maintenance of way and structures per mile of road was $1,185 in 1906 and $945 in 1905. Maintenance of equipment was $2,850 per locomotive in 1906 against $2,895 in 1905; $863 per passenger car in 1906 against $851 in 1905, and $65 per freight car in 1906 against $94 in 1905. A largely increased amount under this head was spent for repairs and renewals of shop machinery and tools, against which was charged $575,000 in 1906 and $42,100 in 1905.

Along with the betterments to the property, both gross and net earnings showed increases during the fiscal year ended June 30, 1906. Gross earnings were $7,568,000 against $6,894,000 in the preceding year, a gain of $675,000. Operating expenses increased $444,000, leaving net earnings of $2,036,000 against $1,800,000 in 1905, a gain of $230,757, or 12 per cent. Even with the increases in charges through the new interest payments on short term notes and equipment notes issued during the year, net income was larger by nearly $200,000 than in the previous year.

Freight traffic density increased from 887,000 tons of revenue freight one mile per mile of road to 1,061,000. The ton-mile rate increased from 0.0729 cents in 1905 to 0.0679 cents. There were 19 tons of revenue freight carried in each loaded car. The number of ton-miles of company freight increased nearly 100 per cent. owing to the large amount of construction material which was being moved. Freight earnings per mile of road were $7,204 against $6,469 in 1905.

Under the head of commodities carried there were important increases in the tonnage of grain and petroleum and other oils, both of which classes of traffic were larger by 100 per cent. than in 1905 and in steel and iron products and miscellaneous tonnage. On the other hand there were decreases in tonnage of cotton, coal, stone and sand. Of the grain tonnage of 229,000 tons 206,000 tons originated on the Kansas City Southern.

The following table sums up the principal results of operation for the Kansas City Southern, including the Texarkana & Fort Smith, comprising the lines in Texas:

	1906.	1905.
Mileage worked	827	839
Passenger earnings	$945,208	$811,192
Freight earnings	5,958,153	5,427,507
Gross earnings	7,568,332	6,893,656
Maint. way and structures	981,104	800,693
Maint. of equipment	1,184,080	1,188,163
Conducting transportation	2,854,696	2,598,278
Net earnings	2,036,057	1,805,300
Net income	933,055	610,192

Canadian Northern.

The Canadian Northern is probably the most rapidly growing railroad system in America. Starting some seven years ago with a small mileage, it sub-leased from the province of Manitoba the Northern Pacific lines in that province and has since, by rapid building, extended its mileage in direct operation to 2,500 miles. At the same time in eastern Canada short railroads have been acquired or built and are now held by allied corporations. During the past year these subsidiary companies have been consolidated and unified, so that now the Canadian Northern interests in the East are comprised in three groups: the Halifax & Southwestern in Nova Scotia; the Canadian Northern Quebec Railway in Quebec, the nucleus of which is the former Great Northern Railway of Canada; and the Canadian Northern Ontario Railway, whose existing mileage is largely made up of the recently opened line of the former James Bay Railway between Toronto and Parry Sound. It will be seen from the accompanying official map that the plans of the Canadian Northern are most ambitious. Besides a line to Fort Churchill on Hudson's Bay, the first 100 miles of which are already under construction, a through line from the Atlantic seaboard in Nova Scotia and New Brunswick via Quebec, Ottawa, Sudbury, Winnipeg and Edmonton to the eastern boundary of British Columbia is indicated, with completion of one of the westernmost lines to the Pacific undoubtedly to follow.

The fiscal year ended June 30, 1906, was marked by the opening of the main line of the Canadian Northern to Edmonton, Alb., and also of the important branch to Prince Albert, Saskatchewan. Another line to Prince Albert was acquired in the Q'Appelle, Long Lake & Saskatchewan Railway, previously the Prince Albert division of the Canadian Pacific. In the East, the James Bay Railway was, on November 19, 1906, opened to regular train service between Toronto and Parry Sound; its extension to Sudbury is to be opened next year. The Canadian Northern Quebec Railway was consolidated with the Great Northern of Canada, the Chateauquay & Northern and the Quebec, New Brunswick & Nova Scotia.

With an average of 2,064 miles operated during the fiscal year,

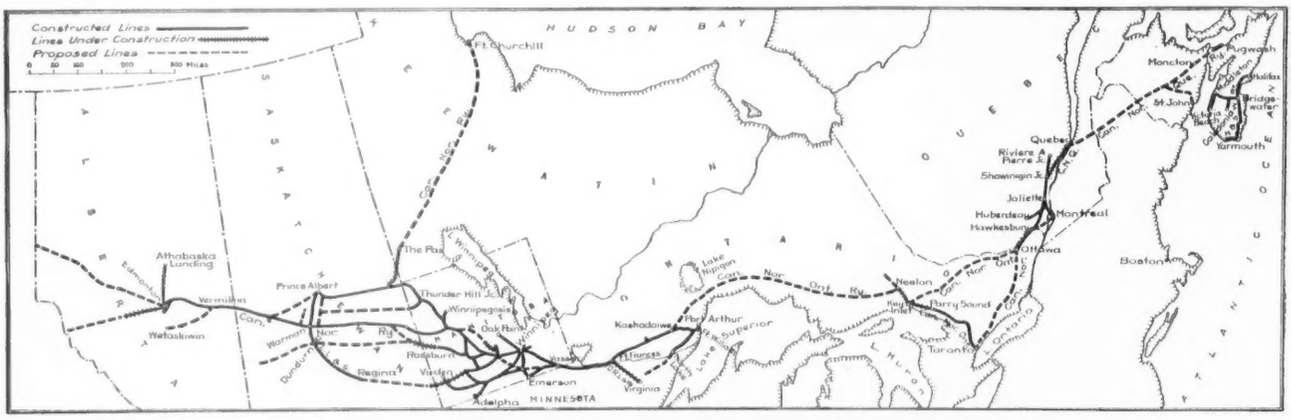
as against 1,586 during 1905, gross earnings were $5,900,000, against $4,190,000 in 1905. Operating expenses were larger by $1,000,000 than in the previous year, leaving net earnings of $2,200,000, against $1,500,000 in 1905. There was a striking gain in passenger earnings, which rose from $660,000 in 1905 to $1,060,000 last year, an increase of 60 per cent., these earnings being 18 per cent. of the total earnings against 16 per cent. in the earlier year. Freight earnings were larger by 43 per cent.; the tonnage moved was 1,727,002 tons, compared with 1,368,896 tons in 1905. Of the increase, grain and flour contributed 179,596 tons, logs and lumber 45,000 tons and general merchandise 99,000 tons. The report calls attention to the large increase in traffic throughout the year from movement of grain and cattle and from farming and immigration business. Referred to as the most noteworthy and particularly satisfactory development is the gain in coal, iron ore and other mineral traffic on all parts of the lines, particularly toward the end of the fiscal year. This is spoken of as an especial subject of congratulation, as it will enable the company in future to face years of poor crops, whenever they come, with equanimity. During the present fiscal year a movement of iron ore from the Atikokan range to Port Arthur is expected. A manufacturing plant is being built at Port Arthur, and it is also expected to market some of the ore in the United States. Attention is called to the fact that in the three months of July, August and September, 1906, since the close of the fiscal year, the gross earnings exceeded the figures for the same months of 1905 by $691,600.

The road traffic is classified under nine heads as follows: flour, grain, livestock, logs and lumber, firewood, fish, immigrants' effects, building materials and miscellaneous. There were 16,200,000 bushels of grain carried, as against 9,700,000 in 1905. More than twice as many head of livestock were carried. The rush of settlers to the rich grain growing districts tapped by the Canadian Northern's western main and branch lines is suggested by the fact that while in 1905 there were 1,558 cars of immigrants' effects hauled, last year there were 2,614 cars. Of building materials, 8,955 carloads were carried, as against 5,968 in 1905, another suggestion of the permanent settling of the new districts. Not only have the aggregate amounts of traffic and earnings been greatly increased during the year, but the earnings per train mile and per mile of road have increased. Passenger earnings per train mile were 22 per cent. and freight earnings per train mile, 8 per cent. larger than in the previous year. Gross earnings per mile of road show an increase of 8 per cent. and net earnings 11 per cent. At the same time, the amount required per mile of road to pay the first charges, including leased lines, shows an increase of 10 per cent. There was an increase of 30 per cent. each in the mileage of passenger trains and freight trains. It is interesting to observe, as an example of the low cost of maintenance of recently built lines mileage, that maintenance of way cost $391 per mile, against $351 in 1905.

The present strength and prosperity of the Canadian Northern are, of course, primarily based on the wonderful development of the western provinces of Canada, particularly Manitoba and Saskatchewan, in which two provinces most of its mileage is located. If the general estimates of the future possibilities of this region are accurate, the road has a splendid future from this part of its line alone. It is evidently the intention of its owners not only to secure the profitable local traffic thus obtained, but eventually to carry grain out to the eastern seaboard for export over their own rails. As a study in competitive railroad building, the development of the Canadian Northern, side by side with its two much stronger and more powerful competitors, will be exceedingly interesting to watch. Under present conditions of Canadian prosperity, and particularly with the favor from government bodies—a factor of great importance in Canadian railroad development—it seems entirely possible that the whole ambitious scheme of development may, within not so very many years, be carried out; for the present, certainly, the expectations of the promoters of the road have been most successfully realized.

The operating results for the past two years are as follows:

	1906.	1905.
Mileage worked	2,064	1,586
Passenger earnings	$1,062,639	$633,936
Freight earnings	4,335,933	3,061,531
Gross earnings	5,903,756	4,190,212
Maint. way and structures	807,692	557,261
Maint. of equipment	585,602	410,707
Conducting transportation	2,072,057	1,515,300
Operating expenses	3,674,733	2,644,730
Net earnings	2,229,023	1,545,482
Mileage worked (June 30)	2,482	1,876



Canadian Northern System Showing Proposed Extensions.

NEW PUBLICATIONS.

Strength of Materials, by Professors S. E. Slocum, B.E., Ph.D., and E. L. Hancock, M.S. Published by Ginn & Co., Boston.

The book is intended for use as a text for engineering students. Part I consists of an analytical treatment of the subject and Part II presents a review of the physical properties of the materials of construction. It also presents experimental data for the purposes of the student. The titles to chapters indicate something of the scope of the work; they are: Part I.—Elastic Properties of Materials; Fundamental Relation Between Stress and Deformation; Analysis of Stress in Beams; Flexure of Beams, Columns and Struts; Torsion; Spheres and Cylinders Under Uniform Pressure; Flat Plates; Curved Pieces; Hooks; Links and Springs; Arches and Arched Rabs; Foundations, and Retaining Walls. Part II.—Iron and Steel; Lime, Cement and Concrete; Reinforced Concrete; Brick and Building Stone; Timber; Rope, Wire and Belting.

The presentation of the subject of Hooks, Links and Springs is by a simple graphical method which has not before been published in this country. The chapters on reinforced concrete, timber, rope, wire and belting represents material which has been well selected from the vast amount of experimental data now available. The student is referred to original sources of information and problems are given to serve in testing his grasp of the text.

Professor Slocum is associated with the Department of Applied Mathematics of the University of Cincinnati, and Professor Hancock with the Department of Applied Mechanics of Purdue University at Lafayette, Ind.

Proceedings of the Fortieth Annual Convention of the Master Car Builders' Association, Held at Atlantic City, N. J., June, 1906. Published by the Association, J. W. Taylor, Secretary, Old Colony Bldg., Chicago, Ill. Half Leather; 6 in. x 9 in.; 670 pages.

This volume of the *Proceedings* is identical in form and arrangement with those of previous years and contains all of the committee reports, individual papers and the discussions on the floor of the convention. The text and drawings of the standards and recommended practice have been revised in accordance with the action of the Association during the last year. The most important and valuable of the reports include those on brake beams, brake shoes, cast-iron wheels and triple valves. The Association now has 631 members.

The Bituminous Coal Carriers.

In the *Railroad Gazette* of June 1, 1906, a compilation and estimate was made, from the best sources then available, of the bituminous coal hauled by rail during 1905. The following table, compiled by Edward W. Parker, and published in the form of an advance chapter from the "Mineral Resources of the United States," under the direction of David T. Day, Chief of Division of Mining and Mineral Resources, United States Geological Survey, is more

Shipments of Bituminous Coals over the Principal Railroad Lines and Systems of the United States.

State.	Pennsylvania.a	Baltimore & Ohio.b	Frisco.c	Norfolk & Western.	Ill. Central.	Chesapeake & Ohio.	Louisville & Nashville.	Southern.
Pennsylvania	37,069,828	5,298,274	.....	.....	6,615,369	.....	.....	.....
Illinois	875,995	881,893	3,420,428	.....	.....	.....	458,256	790,728
West Virginia	233,745	7,994,392	.....	8,739,077	.....	8,792,671	.....	.....
Ohio	5,091,700	5,652,397	.....	.....	.....	.....	.....	.....
Alabama	.....	.....	1,567,049	.....	65,696	.....	3,125,792	2,454,732
Indiana	2,463,853	26,273	2,868,176	.....	488,206	.....	.....	638,657
Kentucky	.....	.....	.....	101,432	2,253,289	142,169	3,814,623	231,038
Colorado	.....	.....	.....	.....	.....	.....	.....	.....
Iowa	.....	.....	.....	.....	7,195	.....	.....	.....
Kansas	.....	.....	2,286,631	.....	.....	.....	.....	.....
Wyoming	.....	.....	.....	.....	.....	.....	.....	.....
Maryland	3,446,722	445,603	.....	.....	.....	.....	.....	.....
Tennessee	.....	.....	.....	.....	.....	.....	632,269	2,312,761
Missouri	.....	.....	104,681	.....	.....	.....	.....	.....
Virginia	.....	.....	.....	983,483	.....	.....	148,099	317,258
Washington	.....	.....	.....	.....	.....	.....	.....	.....
Indian Territory	.....	.....	51,038	.....	.....	.....	.....	.....
Arkansas	.....	.....	86,455	.....	.....	.....	.....	.....
Total	49,181,843	20,298,832	10,384,458	9,823,992	9,429,755	8,834,840	8,179,039	6,745,174

a Includes the Pennsylvania Company, Pennsylvania Lines West of Pittsburg, Terre Haute and Indianapolis, Vandalia, and other subsidiary companies.
b Includes the Baltimore & Ohio Southwestern.
c Includes the Chicago & Eastern Illinois.

Shipments of Bituminous Coal Over the Principal Railroad Lines and Systems of the United States.—(Continued).

State.	Burlington.a	Wabash.b	Santa Fe.	Hocking Valley.	Missouri Pacific.c.	Pittsburg & Lake Erie.	Rock Island.d	Chicago & Northwestern.	Big Four.
Pennsylvania	.....	118,584	.....	.....	.....	3,160,319	.....	.....	.....
Illinois	2,756,229	2,812,260	494,508	.....	922,566	.....	686,956	1,280,874	1,923,031
West Virginia	.....	1,533,706	.....	.....	.....	49,294	.....	.....	.....
Ohio	.....	140,050	.....	4,362,250	.....	5,044	.....	.....	43,959
Alabama	.....	.....	.....	.....	.....	.....	.....	.....	.....
Indiana	.....	.....	.....	875	.....	.....	.....	.....	410,649
Kentucky	.....	.....	.....	.....	.....	.....	.....	.....	.....
Colorado	151,564	.....	557,867	.....	.....	.....	15,865	.....	.....
Iowa	1,208,015	228,762	.....	.....	.....	.....	779,824	1,437,250	.....
Kansas	22,649	.....	2,340,929	.....	928,956	.....	22,648	.....	.....
Wyoming	1,081,990	.....	.....	.....	.....	.....	.....	54,744	.....
Maryland	.....	347,509	.....	.....	.....	.....	.....	.....	.....
Tennessee	.....	.....	.....	.....	.....	.....	.....	.....	.....
Missouri	384,787	267,600	188,758	.....	855,592	.....	67,498	.....	.....
Virginia	.....	.....	.....	.....	.....	.....	.....	.....	.....
Washington	.....	.....	.....	.....	.....	.....	.....	.....	.....
Indian Territory	.....	.....	2,083	.....	.....	.....	1,155,843	.....	.....
Arkansas	.....	.....	.....	.....	1,006,742	.....	76,142	.....	.....
Utah	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico	.....	.....	976,785	.....	.....	.....	.....	.....	.....
Montana	.....	.....	.....	.....	.....	.....	.....	.....	.....
Michigan	.....	.....	.....	.....	.....	.....	.....	.....	.....
Texas	.....	.....	.....	.....	.....	.....	40,850	.....	.....
Total	5,605,234	5,448,471	4,560,930	4,363,125	3,693,856	3,214,657	2,845,626	2,772,868	2,377,639

a Includes the Chicago, Burlingtan & Quincy, Burlington & Missouri River, Burlington & Western, Kansas City & Omaha, and other subsidiary lines.
b Includes the Wabash Pittsburg Terminal, Wheeling & Lake Erie, and West Virginia Central & Pittsburg.
c Includes the St. Louis, Iron Mountain & Southern.
d Includes the Choctaw, Oklahoma & Gulf.

Shipments of Bituminous Coals over the Principal Railroads of the United States.

Railroad.	State.	Quantity, short tons.	Total.
New York Central & Hudson River	Pennsylvania	6,307,762	6,307,762
Buffalo, Rochester & Pittsburg	Pennsylvania.	6,291,806	6,291,806
Union Pacific	Colorado	61,282	4,345,174
	Kansas	66,757	
	Wyoming	4,166,852	
	Utah	50,283	
Denver & Rio Grande	Colorado	1,819,233	2,808,242
	Utah	959,009	
	New Mexico	30,000	
Chicago & Alton	Illinois	2,455,409	2,663,085
	Missouri	207,676	
Northern Pacific	Washington	1,936,684	2,648,395
	Montana	666,066	
	North Dakota	45,645	
Colorado & Southern	Colorado	2,289,271	2,289,271
Wheeling & Lake Erie	West Virginia	4,022	2,260,841
	Ohio	2,256,819	
Missouri, Kansas & Texas	Kansas	774,131	2,153,344
	Missouri	103,535	
	Indian Territory	1,193,936	
	Texas	81,742	
Kanawha & Michigan	West Virginia	1,790,254	1,875,521
	Ohio	85,267	
Toledo & Ohio Central	Ohio	1,728,774	1,728,774
Bessemer & Lake Erie	Pennsylvania	1,584,619	1,584,619
Erie	Pennsylvania	1,247,909	1,494,743
	Ohio	246,834	
Cincinnati, Hamilton & Dayton	Illinois	169,754	1,491,340
	Ohio	538,171	
	Indiana	15,328	
	Michigan	768,087	
Evansville & Terre Haute	Indiana	1,415,236	1,415,236
Nashville, Chattanooga & St. Louis	Alabama	14,672	1,087,791
	Tennessee	1,064,537	
	Georgia	8,582	
Missouri & Louisiana	Missouri	529,332	944,778
	Arkansas	415,446	
Chicago, Milwaukee & St. Paul	Illinois	61,461	881,338
	Iowa	819,877	
Iowa Central	Illinois	383,221	839,040
	Iowa	455,819	
Great Northern	Montana	793,665	832,233
	North Dakota	38,568	
Mobile & Ohio	Illinois	628,692	819,441
	Alamaba	190,749	
Cincinnati, N. Orleans & Texas Pac.	Kentucky	273,345	690,260
	Tennessee	416,915	
Kansas City Southern	Kansas	332,641	433,401
	Missouri	17,140	
	Indian Territory.	83,620	
Midland Valley.	Indian Territory	39,399	219,317
	Arkansas	179,918	

The shipments over the railroads which penetrate only one or two states, and which were less than 1,000,000 tons and over 100,000 tons in 1905, have been reported as follows:

Railroad.	State.	Amount, short tons.
Alabama Great Southern	Alabama	111,090
Beech Creek	Pennsylvania	873,095
Buffalo & Susquehanna	Pennsylvania	438,161
Central of Georgia	Georgia	164,113
Central Indiana	Indiana	161,819
Chicago Great Western	Iowa and Kansas	233,303
Chicago & Illinois Midland	Illinois	226,396
Chicago, Indianapolis & Louisville	Indiana	224,589
Chic., Peoria & St. Louis Ry. of Ill.	Illinois	603,107
Coal & Coke	West Virginia	248,027
Colorado Midland	Colorado	282,706
Colorado & Southeastern	Colorado	704,556
Colorado & Wyoming	Colorado	100,921
Columbia & Puget Sound	Washington	654,693
Denver, Northwestern & Pacific	Colorado	178,339
Des Moines, Iowa Falls & Northern	Iowa	123,694
Detroit, Toledo & Ironton	Ohio	759,277
East Broad Top	Pennsylvania	143,952
Elgin, Joliet & Eastern	Illinois	964,430
El Paso & Northeastern	New Mexico	413,594
Evansville & Indianapolis	Indiana	157,172
Fort Smith & Western	Indian Territory	250,311
Georges Creek & Cumberland	Maryland	230,269
Harriman & Northeastern	Tennessee	308,315
Huntingdon & Broad Top Mountain	Pennsylvania	475,809
Illinois Southern	Illinois	173,045
Indiana, Illinois & Iowa	Illinois	215,523
International & Great Northern	Texas	148,193
Iowa & St. Louis	Missouri	256,184
Kellys Creek	West Virginia.	129,426
Lake Erie, Alliance & Wheeling	Ohio	971,065
Lake Shore & Michigan Southern	Pennsylvania & Ohio	157,225
Lick Creek and Lake Erie	Virginia.	440,185
Litchfield & Madison	Illinois	812,165
Louisville, Henderson & St. Louis	Kentucky	101,262
Michigan Central	Michigan	426,334
Minn., St. Paul & Sault Ste. Marie	North Dakota	110,428
Monongahela	Pennsylvania	351,719
New Haven & Dunbar	Pennsylvania	236,863
Newton & Northwestern	Iowa	214,702
Peoria & Pekin Union	Illinois	217,055
Pittsburg & Castle Shannon	Pennsylvania	101,267
Pittsburg, Shawmut & Northern	Pennsylvania	687,415
Quincy, Omaha & Kansas City	Missouri	288,053
St. Louis & Belleville	Illinois	299,723
St. Louis & O'Fallon	Illinois	408,300
St. Louis, Troy & Eastern	Illinois	956,468
Seaboard Air Line	Alabama	177,436
Texas & Pacific	Texas	573,656
Toledo, Peoria & Western	Illinois	189,199
Toledo, St. Louis & Western	Illinois	304,982
Toluca, Marquette & Northern	Illinois	173,753
Virginia & Southwestern	Virginia	333,588
Western Allegheny	Pennsylvania	564,154
Zanesville & Western	Ohio	738,938

complete. The table, of course, involves duplications, but it nevertheless shows that the railroads profited by the carriage, in total, of about 226,000,000 short tons of bituminous, exclusive of roads hauling less than 100,000 tons. The latter brought the total shipments up to a little over 255 million tons for the year. The number of carriers participating in the movement of 100,000 tons or over was 96, exclusive of the separate corporate companies included in the larger systems.

Shop Betterment Work on the Santa Fe.

BY CHARLES H. FRY,
Associate Editor of the *Railroad Gazette*.

The occurrence of the machinists', boilermakers' and blacksmiths' strike of May, 1904, on the Atchison, Topeka & Santa Fe Railway System, was directly responsible for the inauguration by the management of a system of betterment work which marks the Santa Fe as the pioneer in incorporating into railroad practice methods for heightening operative efficiency, refining railroad mechanical practice, and harmonizing relations between employer and employee in the departments affected, which hitherto have been practically confined to commercial manufacturing concerns. The establishing of a movement so radical in character and so revolutionary, far-reaching and complex in many of its effects, on a railroad system the size of the Santa Fe, is a task of such magnitude that even now after two and a half years of wise, systematic and unremitting effort, the work may be said to be only fairly begun; for of the four great divisions of railroad operations it has been applied almost solely to the Maintenance of Equipment accounts, in a small degree to Conducting Transportation accounts, and not at all to the other two—Maintenance of Way and Structures, and General Expenses.

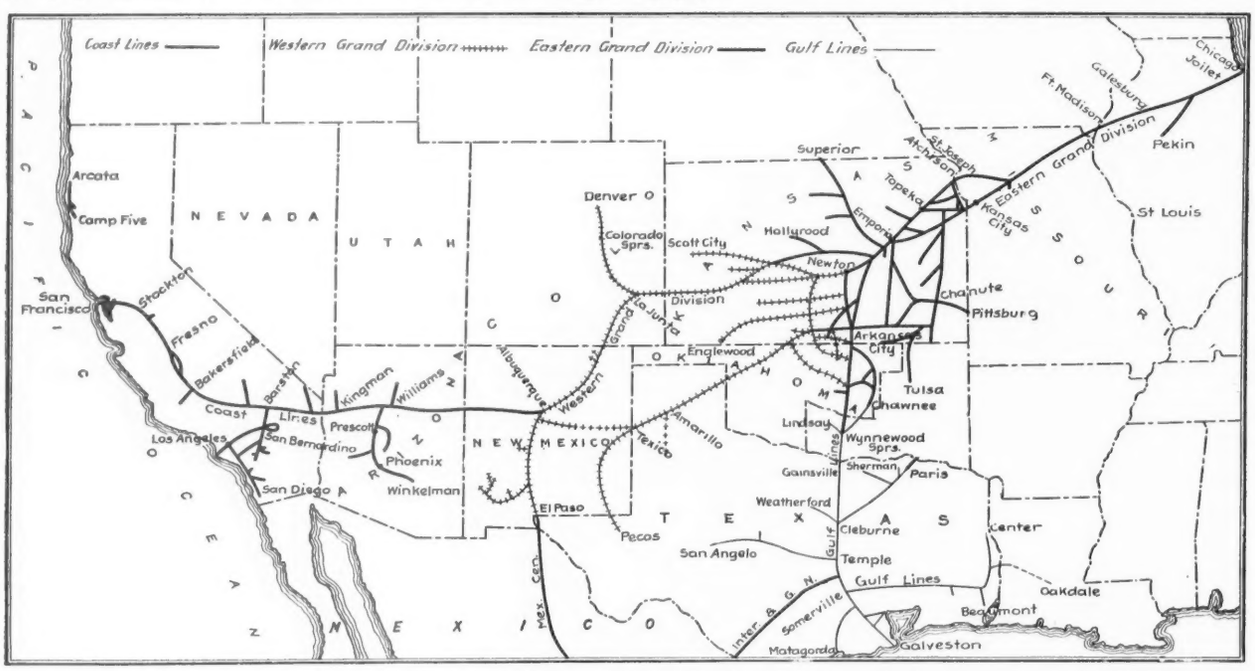


Fig. 1—Map of the Atchison, Topeka & Santa Fe Railway System.

As a first step to getting an adequate idea of the magnitude of the undertaking, the accompanying map of the Santa Fe System should be studied, and its extent and general divisions noted. The System has a total of 8,500 miles. It owns 45,347 cars, of which 44,204 are freight, 995 are passenger, and 148 miscellaneous cars. The total number of locomotives is 1,633. The System comprises the Atchison, Topeka & Santa Fe Railway proper, divided into the Eastern and Western Grand divisions; the Atchison, Topeka & Santa Fe Railway Coast Lines, and the Gulf, Colorado & Santa Fe, or Gulf Lines. The mechanical department of the System is in charge of Mr. Alfred Lovell, Superintendent of Motive Power, and has five major divisions as follows:

Name.	Extent.	Mechanical Supt.	Miles of road.	No. of locos.
1. Eastern Grand.	Chicago to Newton	W. F. Buck	2,600	584
2. Western Grand.	Newton to Albuquerque and El Paso	M. J. Drury	2,650	430
3. Coast Lines	Albuquerque to San Francisco	S. L. Bean	1,800	367
4. Gulf Lines	Shawnee to Galveston	P. T. Dunlop.	1,450	252
5. Topeka Shops	General repair and manufacturing shops of System—John Purcell, Supt.			

Each of the first four major divisions is, of course, divided into the usual smaller divisions, in charge of master mechanics. The Topeka shops are the largest on the System and their superintendent reports direct to the superintendent of motive power. The other shops are under the master mechanics of their respective divisions.

The credit for the introduction of this betterment work on the Santa Fe is due primarily and directly to Mr. J. W. Kendrick, Second Vice-President, and it is to his energy and interest and consistent support of the efforts of those having the work more immediately in charge that their success is due. As already mentioned, the movement was inaugurated during a strike which was characterized by great bitterness. The prime objects of the betterment work as undertaken have been stated to be, in the order of their importance:

(1) To restore and promote harmonious and cordial relations based on mutual respect and confidence between employer and employee.

(2) To restore the worker to himself by freeing him from the small and debasing tyrannies of petty and arbitrary officials on one side and from individuality-destroying, union domination on the other.

(3) To give the company better, more reliable and more trustworthy employees.

(4) To increase automatically and without fixed limit the pay of good men, this increase of pay depending on themselves, not on their immediate superiors.

(5) To increase the capacity of shops without adding new equipment.

(6) To increase the reliability of work turned out and the efficiency of operations performed.

(7) To do all these things not only without cost to the company but with a marked reduction in its expenses.

It was the belief that by increased supervision and special reward, efficiency could be increased and expenses lessened. Increased supervision was to be aided by more frequent and prompt tabulation of various performance records, by special expert investigations of every operation as to man, machine, methods and material, with consequent planning to eliminate wastes of every and all kinds. The work thus far has been limited to the maintenance of equipment accounts and to locomotive operation in its various phases, including repairs, roundhouse, supplies, fuel consumption, engine failures, lessening of delays at shops, adjustment of repair activity to traffic needs, etc. It can safely be said that the betterment work *has* resulted, as anticipated, in restoring harmony between employer and employee, in restoring self-respect to the latter, and increasing his efficiency and reliability. Also it has raised his wages 10 to 20 per cent. on the average. In addition, for every dollar of supervising and special expense incurred, the company has saved at least $10 in reduced costs.

The Shop Betterment Department of the Santa Fe was organized by Mr. Harrington Emerson, Consulting Engineer, who has done the general as well as much of the detail planning and is in supervisory charge of all of the work. He is also local resident for Topeka shops and Eastern Grand division problems. As indicated by the present extent of the work as outlined in the preceding paragraph, the departments through which it had been necessary

to work to introduce the system have been the mechanical, Mr. Lovell, Superintendent of Motive Power; the accounting, Mr. W. E. Bailey, General Auditor; the purchasing, Mr. W. E. Hodges, General Purchasing Agent, and the stores, Mr. N. M. Rice, General Storekeeper. The hearty co-operation of these officers has been an important factor in the success of the work; also that of the mechanical superintendent and the superintendent of shops at Topeka. Mr. Emerson's office assistant is Mr. Clive Hastings, formerly of the Northern Pacific. The special men reporting directly to Mr. Emerson are:

Mr. H. W. Jacobs (formerly of the Burlington and Union Pacific), territorially in charge of all betterment work on the Coast Lines, and functionally in charge of tools and machinery betterments.

Mr. J. E. Epler (formerly of the Burlington; Lackawanna, and N. Y. C. Lines), territorially in charge of Gulf Lines and functionally in charge of all car work.

Mr. S. D. I. Emerson (formerly accountant and manufacturer), in charge of betterment work on the Western Grand division. With him is associated Mr. W. J. Power (formerly of the Union Pacific). These two men were previously in charge of time studies and bonus schedules and of the introduction of individual effort methods at Topeka shops.

Mr. J. F. Whiteford (formerly of the Burlington and Union Pacific), in charge of all betterment work as applied to roundhouses.

Mr. Curtis B. Goode, in charge of power house economies; Mr. Thomas W. Neely, in charge of oil burning economies; Mr. F. L. Hutchins (formerly of the Boston & Maine), in charge of records and "graphs"; Mr. G. S. S. Playfair, in charge of road units records; Mr. E. K. Wennerlund, general assistant on the A., T. & S. F. proper. In addition, each of the above has his own assistants, the total number of men directly engaged on this work in October being 31.

As various facts indicating wastes or chances of improvement are reported to Mr. Emerson's office, all of the conditions are investigated and new methods are evolved and planned. If these involve other departments they are, as the case may require, considered in conference with either the general auditor, the general purchasing agent, the superintendent of motive power, the general statistician, the general storekeeper, the superintendent of shops and the mechanical superintendents, or the general managers. When an agreement has been reached and there is need for final authoritative action, the desired changes are submitted to the Second Vice-President for final approval. This adopts and incorporates the modifications due to the special work into the regular departments affected by these modifications. As examples of this co-operative work the following are cited:

(1) All mechanical pay-rolls and distribution are reported daily by the mechanical auditors.

(2) Specifications as to many supplies have been adopted by the general purchasing agent.

(3) The superintendent of motive power has approved recommendations for standardizing tools and engine parts, and innumerable other recommendations.

(4) The general statistician has put into effect a monthly report of locomotive performance; he has given valuable compilations and comparisons from other railroad systems.

(5) The general storekeeper has always adapted immediately his own department procedures and records to the ofttimes annoying experimental changes, and has directed all division storekeepers to co-operate in every possible way.

(6) The superintendent of Topeka shops, while never abdicating his position as head of these shops, has, after conference and mutual agreement, put into effect locomotive, gang and machine schedules, and has himself introduced the new methods into the blacksmith and certain other departments.

(7) The mechanical superintendents have co-operated as to roundhouse and car work, and as to the smaller shops.

(8) General managers have seconded efforts and carried out recommendations as to power house betterments and as to fuel and supplies for locomotives.

Records of pay-rolls, engine repairs, engine mileage, engine failures, engine tonnage, engine fuel consumption, engine supplies, tool and machinery repairs, and car detentions and repairs, are sent regularly to Mr. Emerson's office and there tabulated and graphed so as to show properly and in the plainest manner the general tendency over the whole System, enabling a comprehensive bird's-eye view of maintenance, shop, engine, car, fuel and supply conditions of the System, as well as of each individual point, to be gained almost at a glance. The method as a whole has been to collect facts, to investigate and to evolve remedies, and to adapt them in conference with regular officers, entrusting the application of remedies to these officers, occasionally, and then only temporarily, lending a hand. The regular graphed records permit of keeping in constant touch with what is going on. When vacancies have occurred and promotion was being considered, the graphical records of individual performance have been carefully considered. Three of the four mechanical superintendents have been promoted to their present positions since January, 1906, and in each case the promotion was made on records previously tabulated in graphical form. The records, had, in fact, selected these men for promotion before vacancies occurred.

The introduction of the betterment work had, of course, to be taken up gradually and locally, it not being possible to take up any branch of the work over the entire System at once. During the first fiscal year (June 30, 1904-5) and, in fact, until October, 1905, it was confined almost entirely to Topeka shops, and consisted in general betterment of shop conditions, etc., in concentration of the manufacture of material and of tools at Topeka, and in starting and establishing the individual effort reward system. The work was then extended as follows:

To oil burning	March, 1905.
To general tool account for System	August, 1905.
To Topeka roundhouse	September, 1905.
To Albuquerque shops	November, 1905.
To Raton and Winslow shops	January, 1906.
To Shopton (Illinois Division shops)	January, 1906.
To San Bernardino ships (Coast Lines)	February, 1906.
To general roundhouse work	April, 1906.
To Cleburne shops (Gulf Lines)	May, 1906.
To car work on System	August, 1906.

As examples of the gradual and local introduction of the work, the efforts on tool account, prior to its extension to the System in August, 1905, were at first confined to Topeka, Albuquerque and San Bernardino, and later were extended to The Needles, Ariz.; no work on oil burning on the Gulf Lines was begun until May, 1905, and car work was first undertaken at Cleburne and San Bernardino, simultaneously, in May, 1906. In what follows the work will be taken up in detail in the order of its introduction, as far as possible, and will therefore need to begin with the work at Topeka.

THE WORK AT THE TOPEKA SHOPS.

The character of the work done at the Topeka shops has already been outlined, consisting of three principal branches: (1) getting shop conditions, methods and equipment in shape for most efficient service; (2) concentration here of manufacture of material and tools for System, and (3) starting and establishing the individual effort reward system.

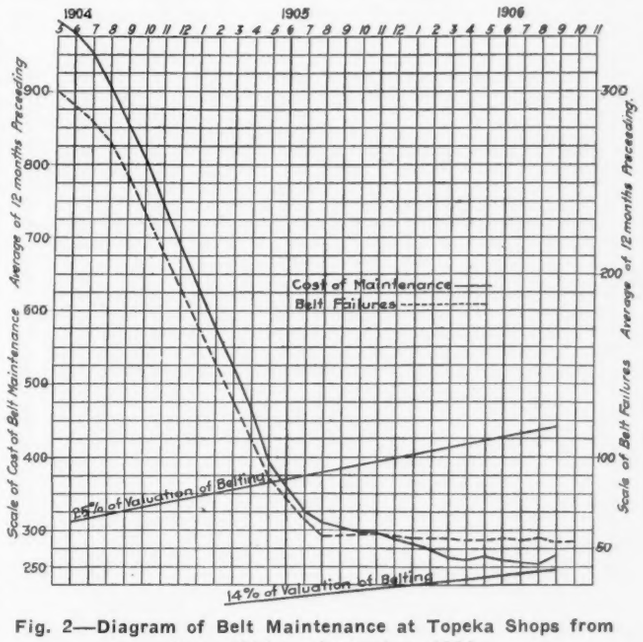


Fig. 2—Diagram of Belt Maintenance at Topeka Shops from May, 1904, to September, 1906.

Betterment of Methods, Equipment, Etc.—The method followed was to determine through specialists and special investigations, in conjunction with the regular shop officials, the best way of doing work, the investigations including man, machine, method and material. It will not be possible to take up here in detail the methods pursued and what was accomplished. The efforts were directed to developing all weak places in the operation as to equipment, power, line shafting, belting, cutting tools, patterns, blueprints, quality of material, delays in waiting for material, etc.; innumerable jigs and special devices for doing work quicker and better and more economically were designed; in short, everything possible was done by skilled specialists to better every shop condition making for improved efficiency.

As a sample of just one feature or item of this work and what was accomplished, a diagram is exhibited herewith (Fig. 2) of the cost of belt maintenance at these shops from May, 1904, to the present time. When the betterment forces took hold, the monthly cost

was $1,000 and the number of failures 300. A rate of $250 a month was set at that time as the ideal to which to work. As the diagram, or graph, shows, the actual expense has now been brought down to an average of $275 a month, all averages being for the 12 months preceding. Failures have fallen from 300 to 55. It should be mentioned that at the outset the figures on cost were for material only, as the labor cost was unknown, no record having been kept. The records now include labor and material. These results were secured by using the best quality of material, and putting its installation and maintenance in the hands of a specialist with instructions to *prevent* failures, not remedy them. A book of rules and instructions for belt repairmen was prepared by Mr. Emerson and distributed on the System; also a rigid set of specifications for belting was drawn up.

Manufacture of Material and Tools for System.—The Topeka shops are by far the largest shop plant on the System. The manufacture of large amounts of stock material for the other shops and repair points on all Santa Fe lines, as well as all firebox and heavy machine work for the Atchison proper, were done here prior to beginning the betterment work. With the introduction of the latter, the concentration of manufacture of finished material was made as complete as possible and, in addition, the policy of centralizing and standardizing tool manufacture at Topeka was inaugurated, with Mr. H. W. Jacobs in planning, directing and executive charge.

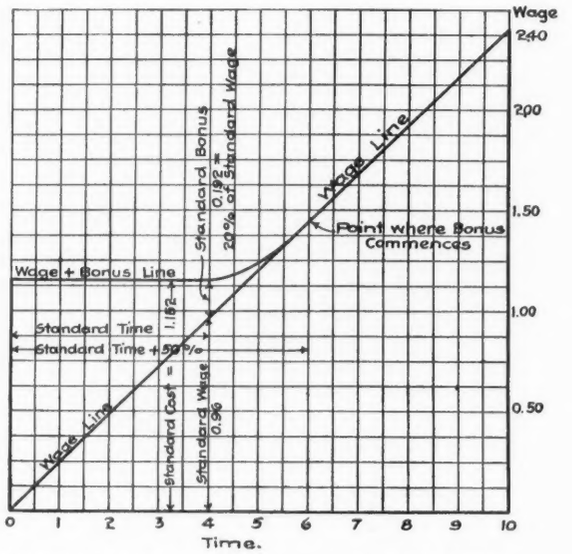
The economy and other advantages of manufacturing in quantities at one central point, suitably equipped, the material for a large railroad system are too well known to need re-statement here. The adoption of such a policy by a road like the Santa Fe not only secures great production economies, but by its intelligent and systematic application the amount of stock to be carried and its cost of handling are minimized, as well as the number of machines, tools and special appliances necessary to its preparation; shops and local repair points, by being furnished with repair parts nearly or entirely ready to apply, are able to make repairs in the minimum time, thus lessening the period of detention of equipment from service. This practice, of course, requires the full co-operation of stores and mechanical departments. To be properly effective, both departments should know well in advance what equipment is to be shopped and what repairs will be required by same, so that the material needed can be made ready. At the Topeka storehouse, where the general stores for the System are carried, is a large finished-material platform, designed and installed by Mr. Rice, the General Storekeeper, which is probably one of the most complete of its sort in the country. On it is carried a large stock of locomotive repair parts finished in whole or in part so that the least possible work needs to be done on them in applying. These parts are sent to all shops on the System as requisitioned. In connection with what was said in regard to minimizing the cost of handling stock under this system, it is of interest to know that the cost of this item at this storehouse is only 1½ per cent., claimed to be the lowest in the world.

Centralizing and standardizing the manufacture of tools at Topeka has been productive of important economies as well as of gratifying results in other ways. The saving on maintenance of tools and machinery account alone for the last fiscal year was $119,000. At the outset this item stood at $486,000 a year—over $40,000 a month. As with the belting account, an ideal for this expenditure was set, the amount being $25,000 a month. It has now been brought down to this figure, yielding the saving above noted, which at the end of a year will equal $180,000. In preparing for this work the requirements of every repair point on the System were carefully canvassed and its actual needs determined. From this, monthly allotments for all points were made up. Careful account is kept of the tools and special devices sent each point and if the allotment is exceeded, inquiry is made and explanation required. All standard tools have symbol numbers, by which all ordering is done.

A very simple but effective system of tool records is kept at Topeka. On the wall of the office of the man having the matter directly in charge is a board carrying three horizontal rows of cards, on hooks. One row of cards lists the standard tools on order in the shops, another the tools on hand in the storehouse, and the third the tools on requisition for outside points. Special devices are entered on separate cards and placed in suitable spaces below the standard tool cards. Record is also kept on the board of the amounts of tool steel on order. Upon removal from the board, all cards are preserved in a suitable filing case. A complete list of the standard tools thus centrally made will not be given, as they include everything from wrenches and chisels to reamers, milling cutters, flue expanders, drills and machine tools. As an example of the practice followed: blueprints showing the form and detail dimensions of every machine tool, with the various symbol numbers and their corresponding sizes, are given every shop and repair point, the tools for which can be obtained only from the general storehouse at Topeka. In ordering, as already explained, it is necessary to give only the symbol number.

The Individual Effort Reward System.—The introduction of the individual effort reward, or bonus system of stimulating employees to extra or unusual effort, and of compensating them suitably therefor, is probably the most important single feature of all of the betterment work, not so much because of its economic results as because of its moral and sociological aspects. These were referred to in the beginning of this article. Furthermore, it is the feature by which all of the improvements in methods and equipment are made to yield maximum results. It is not within the scope of this article to present a description in detail of this system and its benefits, and wherein it differs from piece-work, with which many confuse it, but for the benefit of the uninformed its essential features will be briefly outlined.

The prototype of the shop system of reward for extra effort is the similar system, long used, of rewarding engine crews for extra miles run. That is, engine crews have a given number of miles for a run and a schedule time in which to make it. Failure to make the schedule, through no fault of their own, entitles them to time pay. But if extra effort is made and more miles run than the schedule provides, they are paid for the extra miles. Similarly, for the machine shop a schedule is made out for each operation and a standard time set for doing same, but with this important difference as compared to the road scheme: For making standard time the worker is paid 20 per cent. above his hourly rate. Standard time has been defined as "that time which it ought reasonably to take to do the work without killing effort, but by eliminating every unnecessary waste." If more time than standard is taken for the work the bonus diminishes, until at 50 per cent. above standard time it merges into day rate. If less time than standard is taken, the bonus increases above 20 per cent. But the worker makes day wages in any event. This is all shown graphically in the accompanying diagram (Fig. 3):



Standard time, 4 hrs. Wage rate = 0.24				20 per cent. Bonus. Machine rate = 0.70.			
Hours to do job.	Wages.	Bonus.	Wages and bonus.	H'rly rate of man.	Machine cost.	Total cost; job.	Total h'rly rate.
10	$2.40	.....	$2.40	0.24	$7.00	$9.40	0.94
9	2.16	.....	2.16	0.24	6.30	8.46	0.94
8	1.92	.....	1.92	0.24	5.60	7.52	0.94
7	1.68	.....	1.68	0.24	4.90	6.58	0.94
6	1.44	.....	1.44	0.24	4.20	5.64	0.94
5.8	1.39	.002	1.392	0.24	4.06	5.452	0.94
5.5	1.32	.010	1.330	0.242	3.85	5.180	0.942
5.2	1.25	.025	1.275	0.245	3.64	4.915	0.945
5	1.20	.039	1.239	0.248	3.50	4.739	0.948
4.9	1.18	.049	1.229	0.251	3.43	4.659	0.951
4.6	1.10	.084	1.184	0.257	3.22	4.404	0.957
4.3	1.03	.130	1.160	0.269	3.01	4.170	0.970
4	.96	.192	1.152	0.288	2.80	3.952	0.988
3	.72	.432	1.152	0.384	2.10	3.252	1.084
2	.48	.672	1.152	0.576	1.40	2.552	1.276
1	.24	.912	1.152	1.152	0.70	1.852	1.852
0	...	1.152	1.152	Infinity.	...	1.152	Infinity.

Fig. 3.—Bonus Curve, Santa Fe Method, with Typical Schedule and Table of Total Operation Costs.

Assuming standard time to be 4 hours, bonus would begin at 6 hours. For the first hour it is practically insignificant, but the rate of increase is rapid, as both curve and table show. When standard time is passed, the increase in bonus is directly proportional to the reduction in time, and the wage-plus-bonus line becomes parallel to the base line. The sum of wages and bonus is termed the "standard labor cost," which becomes constant when standard time is reached.

As a preliminary to the installation of the bonus system a vast number of time studies had to be made and schedules prepared, as each operation to be bonused required the careful study of competent men to determine from the machine and other conditions the standard time. Up to the present time approximately 4,000 such studies have been made at Topeka shops, nearly all of which re-

ceived the careful personal consideration of the superintendent of shops. There are regular blanks or forms on which these studies are recorded and preserved. From the time study the individual effort schedule is made up on a form, likewise specially prepared for the purpose, having spaces to record the kind of operation, the kind of machine, hourly rate, standard cost, standard rate, standard time, standard bonus, and a schedule number which, according to the system adopted, indicates class of machine, location in shop, and number of the operation scheduled, each machine having, of course, a separate schedule for each different operation performed thereon. Below these entries is the schedule, which shows the wages and bonus for different times, as in the table in Fig. 3. It will be noted that fractions of hours are given in tenths. This practice is uniform throughout this work, as it simplifies greatly all computations involving time, and also insures accuracy. All schedules are officially checked by Mr. Emerson and the superintendent of shops and are approved by the superintendent of motive power. Schedules once prepared and approved are not by any means fixed and unchangeable, however. Should one prove to be unfair to the workman, or to the company, or if any change occurs in man, wage rate, machine, or method of doing the work, the schedule may be changed. But should a schedule prove somewhat high, it stands until the occurrence of some one of the other conditions above noted permits a change to be made. Furthermore, any reduction in time the workman is able to effect by exercise of ingenuity he is allowed the full benefit of, no matter if it yields him abnormally high bonus. The moral and stimulating effect of such policies is readily apparent.

Besides the individual or machine schedules there are gang schedules for all gang work. For an erecting gang, for example, the standard is the wage cost of a standard gang for a full week, for a standard number of engines. If either the gang cost is reduced or the output increased, the bonus to the gang is increased, the total amount being apportioned to the individual members on the basis of wages earned for the week. Reduction of gang cost means doing the work with a less number of men, of course; so that if a standard gang should be run with a reduced force and this reduced force produces standard output, they are bonused for reduced gang cost; if a standard gang exceeds standard output they are also bonused for this increase. The gang foreman is included as a member of the gang and draws his bonus in proportion to his pay; in addition, he is rewarded for getting the work out on or ahead of schedule; but on the other hand he is penalized or fined for delay, and a gang falling behind the schedule number of engines during any week must overcome the shortage before allowance is made for bonus on subsequent work. The system of account keeping is such that a foreman can find out each day what the previous day's gang costs were and be governed accordingly. Shop foremen are bonused or penalized on output and time of delivery, as the case may be.

Bonus slips, or individual effort checks as they are called, are distributed on the morning of each day to each man who earned bonus the previous day, showing the amount earned. This practice constitutes a prompt recognition of the effort and must undoubtedly have a constantly stimulating effect, which would, at least, not be nearly so uniform were all recognition postponed until the 15th of the following month, when the pay checks are received. Furthermore, it enables the employee more readily to keep account of his bonus.

Cost Accounting.—In connection with the bonus system a complete system of cost accounting is in effect at these shops. By its use accurate record is kept of the cost of every operation, enabling the cost of any piece of work or manufactured article readily and accurately to be determined. As pointed out by Mr. Emerson in these columns last week, it is simply the application to railroad shop work of the methods of any properly administered manufacturing plant, and consists in adding to the cost of direct labor and material the proper surcharge or percentage of general expenses which should be assessed against the operation. In the method of determining this surcharge lies the success or failure of the system.

General expenses fall under the four heads of rent, supervision, maintenance and operation of equipment, and power (light, heat, water, etc.). From the subdivision and distribution of these expenses to the various shops and departments, and groups of men and machines, the man and machine surcharges are determined. The machine charge is reduced to an hourly rate and is ascertained by multiplying its inventory value by the per cent. of surcharge determined for that group and dividing by the number of hours it is used in the year. Thus, in the table in Fig. 3 the machine rate is 70 cents and the machine cost added to the labor cost gives the total in the next to last column. On the average, it costs close to $1 an hour to operate a man and machine, whether he works slow or fast, therefore the economy of fast operation is apparent.

At Topeka, time distribution clerks enter on "distribution cards" each day complete information concerning each man, his machine, nature of work, material, schedule number, rate, time and bonus. This card is also the man's "clock" card, his time of registering in and out being automatically recorded on it. The cards are turned in nightly to the motive power accountant and from them the pay-roll and all other records are made up. One of these is the operation cost record—a card 5 in. x 8 in.—one of which is used for each schedule. On this card is set down all necessary information concerning the cost of any particular operation under the schedule in question, there being room on the card for 80 entries. The cards are filed under the machine and schedule numbers and enable close track to be kept of every kind of work being done.

Mechanical tabulation of records is also in practice. Hollerith tabulating machines are used, the essence of the system being "to make the record by means of punched holes in cards." There are three operations, requiring three different machines: (1) Punching records on cards; (2) sorting into groups, and (3) tabulating. Punching can be done by one man at the rate of 1,500 to 3,000 cards a day; sorting at the rate of 200 a minute, and tabulating at the rate of 40 a minute. One card is used for labor distribution and another for bonus earned, the two being made up from the daily time distribution cards. A great variety of facts, which cannot be enumerated here, can be determined from these cards quickly by means of the machines. But it is said with reference to their use, that if operations are not to be followed into details, if betterment by comparison is not to be consistently carried out, they are a useless expense.

Shop Methods and Practices.—In conjunction with the betterment work already described, the general method of handling locomotive repair work through the shops was revised in many respects and special features introduced to expedite work and enable careful supervision and full knowledge of progress and general conditions to be maintained.

Standard times for making the three classes of repairs were established, the periods being: General repairs, 26 days; heavy repairs, 15 days, and light repairs, eight days. Few light repairs are made at Topeka shops, such as are done being only of an emergency character; but all heavy and general repairs for the Atchison proper are made here. The practice of requiring from master mechanics notification well in advance, when possible, regarding equipment needing to be shopped, in order that the material may be got ready, as far as practicable, before the engines are withdrawn from service, has already been referred to. When the engine arrives on the hospital track the master mechanic's report of its general condition is in the hands of the superintendent of shops. As soon as the engine comes to the shops a special inspector who has charge of all such work, looks it over and makes a "condition" report, giving condition of firebox, flues, smoke-arch, driving-wheel centers, tires, frames, cylinders, cylinder saddles, crossheads and tender. The estimated cost of boiler repairs is also entered. When the engine is stripped, this inspector is present and makes up an itemized list of all repairs that are needed. These repairs are then apportioned to the proper departments and gangs, each receiving a slip stating just what work it should do. Carbon copies of these slips are bound together, forming a record in detail of all work done on the locomotive at this particular shopping. The first sheet of this packet gives time of arrival on hospital track, time taken into erecting shop, scheduled time out, name of foreman in general charge of the work, and a brief statement of the character of repairs to be made.

As soon as the inspector's list is made up, an expert estimator prepares from it an itemized estimate of the cost of the repairs, which is sent to the shop superintendent, and nothing more than appears on this list and estimate is permitted to be done to the engine except by direct authorization of this officer. This prevents the doing of any unnecessary work, promotes carefulness and stimulates efficiency. When the job is completed the actual costs are made up from the records and entered in a column parallel to the estimate, enabling comparison of the two to be made, and kept on record. It is interesting to know that these estimates now show an accuracy in their totals of within about 2 per cent. on an average. Individual items vary considerably, of course, but the totals agree quite closely in the majority of cases.

When these repairs are completed the engine is taken out for a trial run. From this run and a careful inspection, the engineman makes a report on what he finds still needs to be done, such as various small adjustments, etc., and not infrequently more important things, which were down on the inspector's list and the workmen failed to do. At the end of the trial run the engine is put in the roundhouse and the inspector goes over it again, adding to the engineman's list anything he may find the latter to have omitted. The foreman is then allowed five hours in which to do what is required, each gang foreman being held responsible for his part of the work. If more than five hours is taken, penalty is inflicted by deducting from the bonus on this engine, if one has been earned. If not, it is charged up, to be liquidated on other work.

In order that he may have constantly under his eye an accurate representation of the general shop condition, Mr. Emerson

devised a "locomotive board" for his office, from which he can tell at a glance what power is awaiting or undergoing repairs and the progress of the latter. The board has a series of small horizontal shelves carrying small cubical blocks, each of which bears the number of a locomotive. The six sides of the block are differently colored and the position of the block permits any one of 24 different facts or classifications to be presented. The board ruled vertically with lines to represent days, and the progress of an engine through the shop is indicated by moving the block bearing its number along the shelf a day at a time. The board is divided to correspond to the "east" and "west" shops, which is the way the longitudinal-track erecting shop is divided for convenience, each half being under a separate foreman. Each of these board sections is subdivided to correspond to the three classes of repairs, and also has subdivisions for the boiler shop and the hospital track respectively. A duplicate board is in the office of the general storekeeper. Mr. Purcell, Superintendent of Shops, has a locomotive board in his office which supplies much the same information, but on which he uses plugs inserted in holes, instead of shelves and blocks. On the circular top of the plug is pasted a piece of paper on which is written the essential information concerning the engine it represents.

Despatching System.—One of the most novel, ingenious and helpful of the various special schemes which have been devised in furthering the effectiveness of the betterment work in the shops is a "despatching" system, the idea of Mr. Hastings, Mr. Emerson's office assistant. Like the bonus system, the idea is taken from the similar feature in railroad operation and was worked out in practically the same way that a train schedule is prepared; the movements in this instance being those of pieces of work or material, instead of trains, and the "stations" being machine tools or workmen. The analogy is carried out to the point of having a central despatcher who has charge of the assignment of every job to the various machines or workmen, who knows as accurately as a train despatcher the location and progress of every such assignment, and who "favors" important jobs which for some reason may be delayed and are therefore off schedule just as delayed important trains are similarly favored. The operation of this unique scheme involves the use by the despatcher of a despatching board and a telephone system for issuing orders and receiving reports. Work of this character must, of course, be in thoroughly competent hands. W. J. Jury, formerly foreman of the east side machine shop, is despatcher and operates the system from his office.

The despatching board is the most important single feature of the system, but before describing it the "shop schedule board" should be explained. The despatcher and every gang foreman has one. On a board of a convenient size for handling is pasted a blueprint which is divided vertically into thirds for light, heavy and general repairs respectively, in parallel columns. It is ruled horizontally for days. In each of the three repair columns is listed in consecutive order the various operations to be performed on the engine by the different departments and gangs, with the proper number of day spaces intervening between the several groups of entries corresponding to the schedule time allowed for the performance of the work; the total times being those already given—eight, 15 and 26 days respectively. Between each pair of repair columns—that is, between light and heavy, and heavy and general—there is a narrow piece of cardboard arranged to slide vertically and ruled horizontally to correspond to the day lines of the schedule, and numbered for the working days of the month. When an engine enters the shop its number is set down on one of these strips alongside the number corresponding to the date of entry. Then by moving the strip so as to bring this date in register with the first line of the proper repairs column, which is marked "stripping"—the first operation to be performed, of course—the dates on which all subsequent operations must be finished can be read off at a glance. The sliding strips can be taken out quickly and replaced when they become filled up. This board enables the foreman and the despatcher to keep a check on the progress of each engine, noting whether or not it is keeping up to schedule.

The despatching board is, in fact, three large boards, corresponding to the three principal sections of the shop, each standing on an easel. The three are grouped immediately back of the despatcher's desk. A photograph of one of the boards is reproduced herewith (Fig. 4). Secured to the board by thumb-tacks is a sheet of paper practically as large as the board. Over this sheet is hung a light sheet-metal framework having ten vertical members, which divide the frame into nine sections. There are four horizontal sections formed by the light rods used to secure the frame to the board. The vertical members have their edges notched to form a series of clips for holding narrow cards. Each of the horizontal spaces has the foundation paper ruled by pencil into six spaces corresponding to the working days of the week. The vertical and horizontal divisions give the board here shown 36 subdivisions.

At the top of each subdivision is written the number of some machine in the shop, there being sufficient subdivisions on the three boards for all machines, benches, etc., to which assignments are made. When an assignment is made, the character of the work, engine or shop-order number, and number of machine to which assigned, are written on a small card, such as are seen on the board, and the card placed on the board under its correct machine number. Different classes of work are indicated by different colored cards, there being six, as follows:

White: Repairs for engines in the shop.
Blue: New material for engines in shop.
Green: Stop-order work for System. (Manufactured material to be shipped to other points).
Red: Emergency work; takes precedence over all other.
Pink: Repair work to tools and machinery in all departments of the shop.
Yellow: Special, for some new switch engines being built in the shops.

As will be noted from the number of cards in many of the subdivisions, most machines have a large number of assignments, each having several jobs ahead waiting to be done. The job being worked on has its card put at the top of the section just below the machine number. When a job is finished the entry on the card is transferred

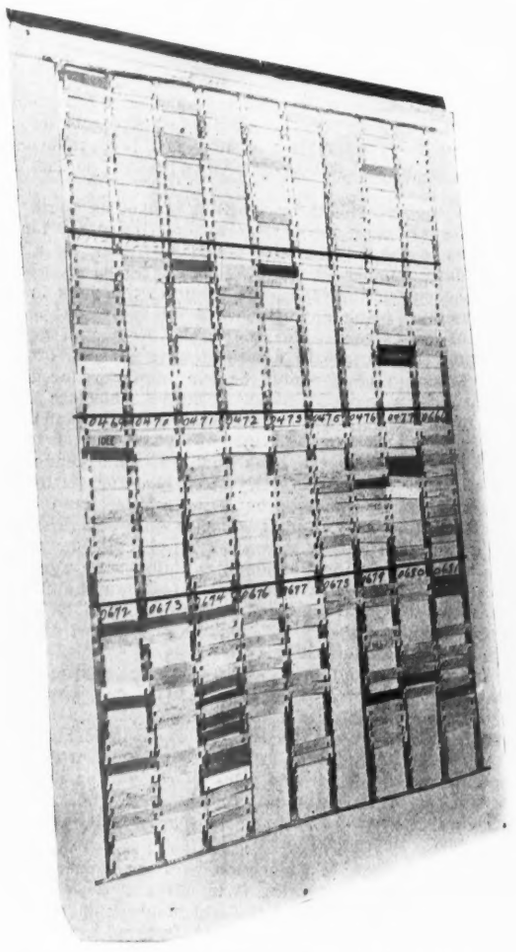


Fig. 4.—Board Used in Shop Despatching System.

to the foundation sheet in the proper day space and the card thrown away. The workman must receive from the despatcher instructions as to which of his waiting jobs must be taken next, and the card for same is moved to the top of the row. The foundation or record sheet is renewed each week, the old sheets being preserved for record.

The despatcher has a list of the engines in the shop, with time in and scheduled time out, which is corrected daily from the shop superintendent's office. This is his primary guide in the assignment and apportionment of work. The initial step in the procedure under this system is the filling in by a gang foreman of a requisition for material he wants made, giving engine number or shop order number to which same is to be charged. This is delivered by messenger to the despatcher, who files it in a case on his desk along with numerous other similar requisitions which are coming in constantly, pending assignment to the machine which the despatcher will select for the work. When the assignment is made, the despatcher puts his "o.k." on the requisition together with the number of the machine, a card is made out for the board, and the requisition is sent to the machine whose number it bears. When the job is done the requisition is returned to the despatcher,

the card is removed from the board and the necessary notation made on the foundation sheet in the proper day space. Also the requisition is filed for record.

Reference has been made to the use of a telephone system. There are three independent telephone lines connecting central points in the three principal shop divisions with the despatcher's office, where there are three separate telephones. Timekeepers report over these telephones the exact time of completion of each piece of work and the time of beginning the next piece, stating nature of same. Foremen usually notify the despatcher by telephone somewhat ahead of the completion of each piece of work, so that instructions can be given for the succeeding piece and thus avoid delays between jobs.

For manufactured goods for stock, the store department sends its order to the despatcher. When he is ready to assign the work he makes out a requisition for the rough material, which he sends to the workmen selected for the work, just as with the foremen's requisitions.

It will be seen that the despatching system enables the man in charge to maintain a constant survey of all of the work subject to his orders. By looking over his board he knows in a moment exactly what job each machine is engaged on and what is waiting at that machine to be done. If one machine appears to have accumulated a large number of assignments and another similar machine has fewer, one or more jobs may be shifted; or if a machine is put out of service for some reason, its work is immediately reassigned if necessary. This also enables important jobs off schedule to be favored, as noted at the outset.

Reference has been made to the variety of special devices, such as jigs, templets, etc., that have been devised to expedite work in the machine departments. Certain of the foremen and men have displayed great ingenuity in devising special appliances and processes to quicken and cheapen production; and, of course, the bonus system has had a stimulating effect on efforts in this direction. Notable among these is George Fraser, foreman of the blacksmith shop, who has done a great variety of work of this sort, much of it before the betterment work was ever thought of. As a single and interesting example of Mr. Fraser's ability in such things, he designed a brakeshoe-key forging machine, rebuilding an old bulldozer for the purpose, which turns out the keys in great quantities at little cost, 1¼-in. round scrap iron being used for the purpose. These keys were formerly made by hand. Another foreman who has been prolific in ideas of great merit and money value is G. Osman, of the brass department. Some of Mr. Osman's work, particularly in the matter of special forms of box and undercut tools, was described in these columns two years ago (*Railroad Gazette*, June 3 and September 2, 1904). Mr. Osman has continued the good work and further increased the already high efficiency of his department. H. I. Derby, foreman of the tool manufacturing department, also has produced interesting special tools to reduce operations and thereby save time and cost.

All of the locomotive department at the Topeka shops has not yet been put on the bonus system, although it is being extended as fast as practicable. At present the erecting floor is the only department altogether on a bonus schedule, the proportions in other departments being as follows: Machine shop, 65 per cent.; blacksmith shop, 75 per cent.; brass room, 70 per cent.; air pump and injector department, 50 per cent.; tin shop, 50 per cent.; tool manufacturing room, 5 per cent., but being increased. The boiler shop has not proved easy to schedule, and a very small percentage of the work is at present on bonus.

As would naturally be expected, the shop administration at Topeka is of high character. Graphical evidence of this is exhibited in the accompanying diagram, Fig. 5, which is the hourly payroll chart for the shops, based on total hourly rates, the uniformity of the lines throughout the several months charted being good evidence of the results of system. In strong contrast, as exhibiting the reverse conditions—that is, poor administration, lack of system—Fig. 6 should be noted. It records actual conditions at another shop on the System, much smaller than Topeka, as the hourly rates indicate, to which the betterment work has not yet been extended. The lines are a tangle and almost impossible to follow. It is an extreme case, of course, introduced to show what fluctuations actually do occur at some points where poor administration, perhaps combined with unsatisfactory labor conditions, produces results highly detrimental to efficiency and economy. Such points, of course, afford excellent opportunity to test the merits of the betterment work.

In these graphs the ordinates represent the hourly rates, and as noted under Fig. 5, the basis is 54 hours a week. This is not the actual number of hours worked each week, but an assumed working period of 9 hours for each work day. This was adopted to eliminate variations between short months like February, September and November, and long months like March, August and October.

(To be concluded.)

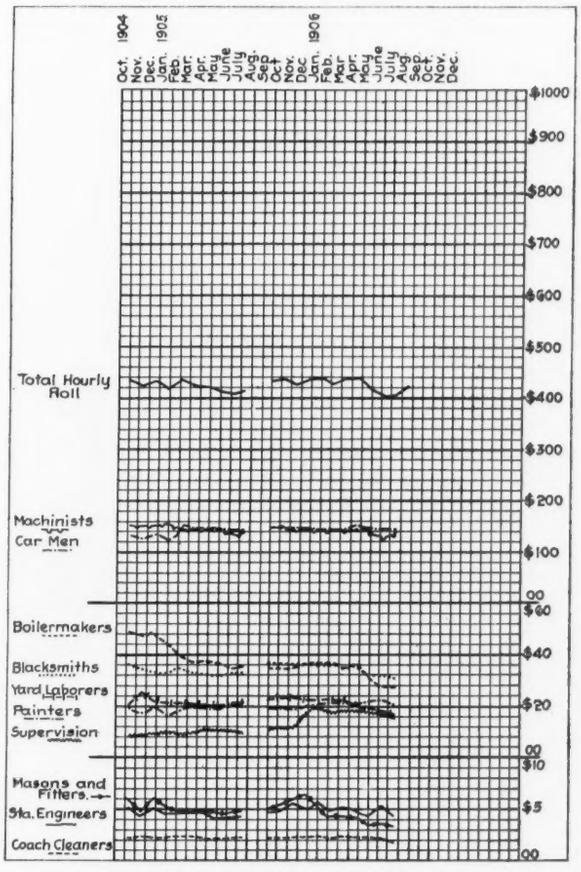


Fig. 5—Hourly Pay-Roll Chart for Topeka Shops (on the Basis of 54 Hours per Week.)

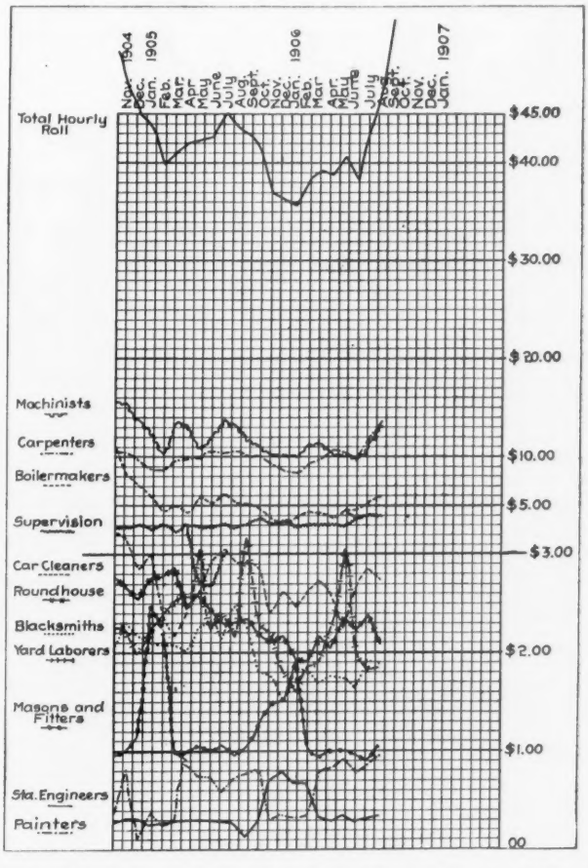


Fig. 6—Hourly Fay-Roll Chart of Shop Where Betterment Work Has Not Yet Been Introduced.

The Railroad Gages of India.*

(*Concluded from page 458*).

It is hardly necessary in this institution to demonstrate the advantages of uniformity of gage, but it may not be out of place to mention the more important benefits to India that would result from uniformity. It would eliminate the troubles and expense of transhipment and the maintenance of the intricate tracks that are unavoidable where the two systems converge at the great centers of trade, the seaports and the coal fields. It would afford India a much wider field to draw upon for rolling stock when, as often happens, there is a glut of traffic in one particular area, such as may be occasioned by the natural effects of a normal rainfall producing heavy crops, or by a deficiency in the rainfall causing a famine; either of these causes results in abnormal movements of grain foods. Military concentration of troops, material and supplies has the same effect. In India the periods of trade and the movements to or from the seaboard are irregular, and the set of traffic frequently changes; for these reasons it is absolutely necessary to provide a full equipment of rolling stock to meet a maximum traffic for a short period, although the stock may not be fully employed throughout the year. It is evident that the distribution of rolling stock would be immensely facilitated, and the equipment more effectively and economically utilized, if the whole country were served by one gage. A good deal is done at present by mutual borrowing, when it happens that the movements of commodities on adjacent systems occur in different months; for example, the jute traffic from the interior to the seaboard takes place at a different time from the movement of grain and seed; and as these commodities are served by distinct railroad systems, the latter are able to use each other's rolling stock to mutual advantage. There is no private ownership of railroad cars in India. Some schemes have indeed been proposed, but as they have been based on a guarantee of traffic either from the railroads or from the government, they have not been favorably received. Still, it is obvious that, under the varying conditions of trade, the greater the area served by one gage, the greater will be the possibility of mutual accommodation.

Uniformity may be brought about by changing all meter-gage lines to standard gage, by changing all standard-gage lines to meter gage, or by adopting another intermediate gage, preferably the European gage of 4 ft. 8½ in. By adopting the first course, a change would be made from the less to the more efficient gage in respect of carrying capacity and speed, with considerable expenditure of money. The second course would provide a lower standard of carrying capacity, with a comparatively smaller outlay. The third course would be more costly and certainly more prolonged than either of the other two. In reviewing these three methods it may be assumed that the ultimate limit of capacity is proportional to the gage when that limit is reached; but until the volume of traffic has attained its ultimate limit on any gage there is no loss of power. The theory that the gage of a railroad is the fundamental unit of measurement to which all other dimensions should be proportional, ought to be governed by the foregoing qualifications. Now that the traffic of some of the single meter-gage lines has outgrown their carrying capacity, the question has arisen whether it would be better, in the present condition of the system of Indian railroads, to substitute a single standard-gage track or to double the meter-gage line. There is no doubt a great deal to be said in favor of a uniform gage of 3 ft. 3⅜ in., but the existence of 14,477 miles of standard-gage track against 11,421 miles on the meter-gage actually constructed, must greatly modify the aspect of the problem, although the conversion of the existing rolling stock from standard to meter gage is a much greater difficulty than the reverse.

While admitting the obvious advantages of uniformity of gage, there is an equal danger of purchasing it at too dear a price. On examination of Tables I. and II., the great difference in capital cost of the two gages—£11,775 per mile for the standard gage, and £4,700 per mile for the meter gage—is at once noticed. It must be remembered, also, that when the construction of railroads was begun, in 1845, on the standard gage, the cost was much higher than it was 30 years later. Very high rates had to be paid to contractors in order to induce them to undertake the risks attending novel works in a foreign country, where there was nothing to establish a precedent as regards cost of construction. There is also to be taken into account the fact that 9 per cent. of the standard-gage lines is double track; but, allowing for this, although the Government Administration Report on all the railroads in India gives the cost of the standard and meter-gage lines as £10,666 and £5,133 per mile respectively, the difference in capital cost affords ample justification for the early policy of adopting the smaller gage: had it not been allowed, about 5,000 miles of the present lines would probably not now be in existence. At no time has there been any serious attempt to lay down an inexpensive standard-gage line equipped with suitable light rails, rolling stock and station accommodations; and, indeed, the existence of a sanctioned narrow gage has prevented this from being done. Possibly, however, it may be argued that, had only the standard gage been allowed, this light system might have come into existence, although the severe conditions of equipment which obtain in India lead rather to the opposite conclusion.

*From a paper presented before the Institution of Civil Engineers by Sir Frederick R. Upcott.

It is interesting to note that the return on capital and the cost of working of the two gages are nearly alike. Incidentally it is significant that the smaller gage carried, in the year 1903, a larger average number of passengers per train than the standard gage; the difference in the average tonnage per train is accounted for almost entirely by the larger number of branches on the meter-gage lines, and by the coal fields being served almost entirely by the standard-gage lines. The difference in carrying capacity of the two gages may be taken from the statistics in a variety of ways, with considerable difference between the results. Table IV. shows the average speeds to be 23, 12 and 15 miles per hour on the standard-gage, as compared with 18, 10 and 13 miles per hour on the meter-gage lines, for passenger, mixed and goods trains respectively. Neglecting these small differences, and making the reasonable assumption that an engine of either gage will pull an equal number of vehicles or wagons, then, since a four-wheel standard-gage passenger vehicle will hold 60 passengers, and a four-wheel meter-gage coach only 40 passengers, and since a four-wheel standard-gage wagon will carry 16 tons and a four-wheel meter-gage wagon only 10 tons, the ratio of the passenger-vehicle capacity of the standard-gage to that of the meter-gage is found to be 1.5 to 1, and the ratio of the goods wagon capacities 1.6 to 1. Also, from the gross weight of a train, neglecting speed, the ratio of the train capacities is found to be 1.4 to 1 for passenger trains and 2 to 1 for goods trains. In the following table are shown, in addition to the foregoing, the ratios of the carrying capacities of the two gages, obtained by some of the other methods of comparison, compiled from the Railway Administration Report, but confined to the 16 lines which have been taken as examples:

		Ratio—Standard gage.	to	Meter gage.
Vehicle capacity only	Passenger	1.5	to	1
	Goods	1.6	"	1
The same, taking speed into account	Passenger	1.9	"	1
	Goods	1.9	"	1
Gross weight of trains	Passenger	1.4	"	1
	Goods	2.0	"	1
The same, taking speed into account	Passenger	1.9	"	1
	Goods	2.4	"	1
Vehicle mileage, loaded and empty	Coaching	1.9	"	1
	Goods	2.8	"	1
The same, taking speed into account	Coaching	2.4	"	1
	Goods	3.3	"	1
On actual number of passengers carried	1 mile	2.0	"	1
On actual number of tons carried	1 mile	4.7	"	1

It will be observed that, whilst the benefit to be derived from conversion is greater for goods trains than for passenger trains, it may fairly be assumed that the general capacity of the standard gage is double that of the meter gage, under the conditions of speed, power of engines, and design of coaches and wagons at present obtaining in India. An independent check on the foregoing is afforded by the ton-mileage per engine. The engine of the principal standard-gage line (the East Indian) accomplishes on an average 7,838 thousand, and that of the principal meter-gage line (the Bengal & North Western) 3,962 thousand ton-miles. It may also be mentioned incidentally that the ratio of the total gross earnings derived from the goods traffic of both gages, to that from the passenger traffic, is 1.9 to 1, and of the total gross earnings derived from the whole traffic of the standard gage to that from the meter gage, 3.05 to 1.

In estimating the cost of converting from meter gage to standard gage, it must be remembered that the Indian government has laid down certain rules governing axle-loads on girder bridges and on rails; but the precaution is now to be adopted of renewing with standard-gage girders girders on meter-gage lines which may require doubling in the near future. This entails only a small addition to the cost, as the tendency is towards heavier engines on both gages. The actual cost of converting a meter-gage to a standard-gage line is not a matter of estimate, since particulars of the cost of conversions already effected are available. The figures for the Salt Branch of 50 miles of the North Western Railway were:

	Rupees.	
Land	32,000	£2,150
Formation	70,000	4,659
Bridges	75,000	5,000
Ballast	1,90,000	12,650
Permanent way (75-lb. flat-footed rails and 9-ft. wood sleepers for 41-lb. flat-footed rails and 6-ft. timber sleepers)	10,35,000	69,000
Stations	1,40,000	9,350
Plant	8,000	550
Rolling stock	5,00,000	33,350
General charges	1,00,000	6,650
Total	Rs.21,50,000	£143,350

Equal to Rs. 43,000, or £2,867, per mile.

The cost of converting the Nagpur-Chattisgarh line, 145½ miles

long, taken over by the Bengal-Nagpur Railway, was:

Land	Rs.34,000	£2,250
Formation	2,48,000	16,550
Bridges	8,33,000	55,550
Ballast	4,12,000	27,450
Permanent way	29,36,000	195,750
Stations	2,74,000	18,250
Plant	65,000	4,350
Rolling stock	6,98,000	46,550
General charges	1,38,000	9,200
Total	Rs.56,38,000	£375,900

Equal to Rs.38,750, or £2,583 per mile.

No actual costs of doubling a meter-gage line can be given, as a case has not yet arisen, but the following is an estimate of the probable cost per mile:

	Per mile	
Land	Rs.7,000	£470
Formation	2,000	130
Bridges	8,000	530
Ballast	4,000	270
Permanent way	20,000	1,330
Rolling stock	8,000	530
General charges	1,000	70
Total	Rs.50,000	£3,330

In this estimate, a moderate increase of rolling stock is provided for. It is difficult to say how much will be required, because, owing to the higher speed obtained with a double track, there may not be at first any necessity for material increase of the rolling stock.

Assuming a level road, trains of the same speed and length, and an equal number of trains in each direction, passing alternately under ordinary "line clears"—which is the Indian system of working—the interval which must occur between the passage of two successive trains in the same direction on a single line is equal to twice the longest time taken between two adjacent crossing stations, plus the longest time occupied at any one crossing station in shunting, watering, etc.; and for a double track the interval is equal to the longest time taken between two adjacent stations, plus the longest time occupied at a stopping station, which will be about half of that taken on a single track; thus, theoretically, the increase in the number of trains which can be run in a given time, due to doubling, would appear to be about 100 per cent. In practice, however, the foregoing conditions do not obtain. With speeds varying between 15 and 30 miles per hour and crossing stations not more than five miles apart, the limit of capacity on a single track is about 15 trains in 24 hours, and on a double track 60 or 80 trains in the same time, or about five times the capacity of the single track. At times of great pressure, it has been possible largely to increase the capacity of the single track by running trains in one direction for two or three days together. In England, by working light fast trains with block-stations close together, as many as 200 trains can be run daily on a double track; but nothing like that number has hitherto been attempted in India, owing to the speeds being so much lower, and to the cumbrous system of written "line clears" being still in vogue on most of the lines.

The difficulties and the dislocation of traffic which would be caused by a gradual conversion of any one line would be considerable. It has already been stated that the meter-gage lines are better served by branches than are the standard-gage lines; and unless conversion be effected over an entire system at the same time, it will be necessary to convert the main line section by section, beginning at the junction with the standard-gage line. This would naturally throw the branch junctions into transhipment stations until they could be taken in hand; but even assuming that the conversion can be carried out under the most favorable conditions of long preparation beforehand, the ultimate advantages of conversion to the standard-gage single track, and of doubling the meter-gage track, have still to be compared. The cost has been shown to be about one-quarter more in the latter case. On the one hand, conversion to the standard gage will give double the carrying capacity—at the expense, however, of great dislocation of traffic for the time—freedom of access to all ports and collieries without restriction, complete supplies of rolling stock to meet all conditions of abnormal traffic, higher speeds and greater comfort for the traveling public in more roomy carriages; but all this is coupled with the prospect of having in a short time to double the standard-gage line. On the other hand, the doubling of the meter-gage lines will give at once four or five times the capacity of the single line; it can be carried out by degrees, as funds are available, without any dislocation of traffic; it will provide for, say, another 30 years' increase of traffic; but the seaports will be open to that gage only under great pressure, and at very great cost, while the coal fields will probably remain closed to it. Large towns have not hitherto been found to present difficulties that cannot be overcome, and as the land is acquired by government free of cost, the companies managing meter-gage lines have not been slow to press their claims to equal treatment with the standard-gage lines, in being allowed access thereto.

It seems probable that the meter-gage lines in the south of India will be the first to be considered, with regard to doubling or conversion; then possibly those in Rajputana. The meter-gage lines north of the Ganges river and Assam are fairly isolated, and may be doubled on that gage without fear of prejudicing the question; while Burma is at present wholly isolated, and a considerable time must elapse before its system connects with Assam, or Siam, or China. In the meantime the construction of new lines must go on. Taking periods of 10 years since 1853, when, in Lord Dalhousie's viceroyalty, railroads were begun, the progress has been 2,507 miles up to 1863, 5,697 miles up to 1873, 10,458 miles up to 1883, 18,504 miles up to 1893, and 26,956 miles up to 1903, showing average yearly additions of 250, 319, 476, 804 and 845 miles in each decade; whilst during the five years of Lord Curzon's viceroyalty the average has risen to nearly 1,000 miles. Assuming future advance at the same rate, which will, however, be mostly branches of existing systems now that the main arteries of traffic are complete, it is unlikely that funds will be available for conversion solely for the sake of bringing about uniformity, except in circumstances which do not at present exist. So far, India is not much hampered by the different gages; but it appears to be a wise precaution to look ahead and endeavor beforehand to have a clear idea of what will be to the best advantage of the future development of traffic.

Train Accidents in the United States in October.[1]

rc, 2d, 7 a.m., Grand Trunk, Elston, Ill., a through passenger train ran into the rear of a local passenger train, damaging three passenger cars and injuring several passengers. There was a dense fog at the time.

eq, 2d, Ft. Worth & Denver, Amarillo, Tex., a freight train was derailed by a drawbar which was pulled out and fell between the sleepers of a bridge, wrecking 21 cars; one trespasser was killed and one other man was injured.

bc, 2d, Rutland road, North Bennington, Vt., butting collision between a southbound passenger train and a northbound freight, wrecking both engines and several freight cars; several passengers were slightly injured.

unx, 2d, Louisiana Railway & Navigation Company's Line, Naples, La., a freight train was derailed and the engine was overturned. The fireman was killed and the conductor and three other men were injured, the conductor fatally.

unx, 2d, Louisiana & Arkansas, Winnfield, La., a gravel train was derailed and several cars fell down a bank; one employee was killed and one injured.

†rc, 4th, 5 p.m., Boston & Maine, Lansingburg, N. Y., a regular westbound passenger train, standing at the station, was run into at the rear by a long special train carrying soldiers bound for Cuba, and the three rear cars of the standing train were wrecked, two of them falling down a bank; five passengers were killed and 25 injured.

rc, 4th, 9 p.m., Louisville & Nashville, Lyndon, Ky., passenger train No. 1 ran into the rear of a preceding freight train, wrecking the caboose and three cars of the freight; the passenger engine was overturned and the mail car was ditched; seven trainmen and mail clerks were injured.

eq, 7th, Western & Atlantic, Dalton, Ga., northbound passenger train No. 2 was derailed by the breaking of a driving wheel axle of the engine, the engine being overturned; the fireman was killed and the engineman injured.

unx, 8th, Union Pacific, Evanston, Wyo., an eastbound express train was derailed and four passenger cars were ditched; a number of passengers were slightly injured.

dr, 9th, Union Pacific, Wamego, Kan., a westbound express train was derailed by a broken rail while running at full speed, four cars being ditched; seven passengers were injured.

bc, 10th, Southern Pacific, Ridge, Wyo., butting collision of freight trains, wrecking both engines and several cars; both enginemen, both firemen and one brakeman were killed.

bc, 11th, Louisville & Nashville, Flomaton, Ala., butting collision between northbound passenger train No. 96 and a southbound freight train, due, it is said, to a misunderstanding of orders; three trainmen and six passengers were injured.

unx, 11th, St. Louis, Iron Mountain & Southern, Carondelet, Mo., a southbound passenger train, running at high speed, was derailed at a curve and the engine was ditched. The engineman

[1]Accidents in which injuries are few or slight and the money loss is apparently small, will, as a rule, be omitted from this list. The official accident record, published by the Interstate Commerce Commission quarterly, is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

rc Rear collisions.
bc Butting collisions.
xc Miscellaneous collisions.
dr Derailments; defects of roadway.
eq Derailments; defects of equipment.
dn Derailments; negligence in operating.
unf Derailments; unforeseen obstruction.
unx Derailments; unexplained.
o Miscellaneous accidents.

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

was killed and the fireman was fatally injured; 12 other persons were injured, two of them fatally.

bc, 14th, Southern Railway, Winnsboro, S. C., butting collision of freight trains; two enginemen and one fireman killed, three other trainmen injured.

bc, 14th, 11 p.m., Great Northern, Whitefish, Mont., butting collision between eastbound passenger train No. 4 and a westbound freight train; due, it is said, to a mistake in telegraphic orders. Both trains were running at full speed a few seconds before the collision. Both engines and two baggage cars and seven freight cars were wrecked; three trainmen were killed and two passengers and three other persons injured.

xc, 14th, Southern Railway, Asheville, N. C., a train, consisting of an engine and a caboose which was started and became uncontrollable in consequence of a leaky throttle while in charge of the fireman, collided with a freight train, and six trainmen were injured.

unx, 15th, Chesapeake & Ohio, Ivy, Va., passenger train No. 5, drawn by two engines, was derailed while running at high speed, and both engines fell down a bank; one fireman was killed and both engineman injured, one of them fatally, and 18 other persons were injured.

o, 15th, Philadelphia & Reading, Lebanon, Pa., the locomotive of a freight train was wrecked by the explosion of its boiler, and the engineman and fireman were injured.

dn, 16th, 2 a.m., Chicago & Eastern Illinois, Crete, Ill., a freight train was derailed at a derailing switch and the engine was overturned; the engineman and one brakeman were killed and three other trainmen were injured.

rc, 18th, 9 p.m., Louisville & Nashville, Lyndon, Ky., westbound local freight train No. 3 standing at the station was run into at the rear by a Chesapeake & Ohio freight train, drawn by two engines, and both engines were overturned. One engineman was killed and three other trainmen were injured. Six minutes after this collision a Louisville & Nashville through freight train ran into the rear of the Chesapeake & Ohio train.

bc, 18th, Baltimore & Ohio, Benwood, W. Va., butting collision between a freight train and a switching engine; one engineman was killed and one fireman fatally injured.

xc, 18th, 2 a.m., Louisville & Nashville, Pensacola, Fla., passenger train No. 2 collided with an empty engine, and the engineman of the empty engine was killed.

dr, 18th, Atlantic Coast Line, Dunn, N. C., a freight train was derailed at a frog and the engine and nine cars were wrecked; the conductor and one brakeman were killed and two other trainmen were injured.

dr, 19th, 10 p.m., Atlantic Coast Line, Ruskin, Ga., a passenger train was derailed and the engine was overturned; the fireman was killed and the engineman injured.

19th, Mobile & Ohio, Shannon, Miss., a passenger train was derailed and six cars were ditched; three passengers were injured.

dn, 20th, Central Vermont, North Duxbury, Vt., a passenger train was derailed at a misplaced switch and the engine and first two cars were overturned; engineman and fireman injured.

unx, 20th, 2 a.m., St. Louis & San Francisco, Brandsville, Mo., a passenger train was derailed and a number of passengers were injured.

bc, 21st, Cleveland, Akron & Columbus, Brinkhaven, Ohio, butting collision between an excursion passenger train and a freight train; engineman and fireman of the passenger train killed.

bc, 21st, Great Northern, Monroe, Wash., butting collision between a westbound passenger train and an eastbound freight; three trainmen killed and two others injured.

unx, 21st, Chicago & Alton, Winkle, Ill., a heavy freight engine moving backward was derailed and fell down a bank. The engineman was killed and two other trainmen were injured.

unx, 22d, Midland Valley, Foraker, Okla., a passenger train was derailed and the rear car was overturned and wrecked; 20 passengers were injured.

†unx, 22d, Southern Pacific, Boutte, La., a passenger train was derailed and the first three cars were ditched; 40 passengers were injured, four of them fatally.

xc, 23d, 8 p.m., Cleveland, Cincinnati, Chicago & St. Louis, Beckwith, Ill., passenger train No. 3 collided with a freight train which was entering a side track but had not fully cleared the main line, and the fireman of the passenger train was fatally injured. The engineman was less seriously hurt.

unf, 23d, Chicago Western, Melbourne, Iowa, passenger train No. 5 was derailed at a bridge which had been weakened by fire, and the engine and tender fell through. The engineman was killed and the fireman fatally scalded.

rc, 24th, Cleveland, Cincinnati, Chicago & St. Louis, Kenton, Ohio, a local freight train standing at the station was run into at the rear by a through freight, drawn by two engines, and three cars were wrecked. Two trainmen were killed and five injured.

unx, 24th, Pennsylvania Lines, Bellevue, Pa., a passenger train was derailed and the engine fell down a bank into the Ohio river, and two passenger cars were overturned. The engineman, fireman, three other trainmen and four passengers were injured.

o, 24th, Chicago, Milwaukee & St. Paul, Morton Grove, Ill., the locomotive of a freight train was wrecked by the explosion of its boiler; fireman killed, engineman and one brakeman injured. At the time of the explosion the train was running down grade at high speed, and 29 cars were wrecked.

bc, 26th, Southern Railway, Hickory, N. C., butting collision between a freight train and a switching engine; one fireman killed, one engineman and one brakeman injured.

eq, 26th, St. Louis & San Francisco, Hot Springs, Ark., a circus train was derailed by the breaking of a truck of one car and five cars were wrecked; one man was injured.

unx, 26th, Vicksburg, Shreveport & Pacific, Haughton, La., passenger train No. 1 was derailed and the engine was overturned. Four trainmen injured.

bc, 27th, Cleveland, Cincinnati, Chicago & St. Louis, Durbin, Ohio, butting collision of freight trains. Both engines and 10 cars were wrecked. Four trainmen were killed and two injured. The operator at Durbin forgot an order which he held for the eastbound train and gave it a clear signal. He decamped immediately after the train got away, without waiting to see the result of his error, and has not been heard from since.

xc, 27th, 8 p.m., Alabama & Vicksburg, Vicksburg, Miss., collision between eastbound passenger train No. 6 and westbound passenger train No. 3, at a meeting point, the westbound train being partly on the side track at the time. The eastbound engine was overturned and the engineman fatally injured.

†28th, West Jersey & Sea Shore, Atlantic City, N. J., a passenger train consisting of three cars, the leading car being an electric motor car, propelling the train, was derailed at a drawbridge, while running at good speed, and the whole train fell off the side of the bridge. Two cars were completely submerged. Fifty-six passengers and one trainman were killed and 20 or more passengers were injured. The evidence as to the cause of the derailment was obscure, but a coroner's jury decided that the lift rail at the entering end of the bridge had not been properly fixed in place when the bridge was last closed, and that it projected upward sufficiently to come in contact with the pilot or the front truck, or both. The bridge tender, who, with his assistant, turns the bridge by hand, had, only about 20 minutes before the accident, taken up a red flag from its place on the track within two or three feet of the rail which was out of place, but testified that at the time he took in the flag the rail was exactly in place. This accident was reported in the *Railroad Gazette* of Nov. 2 and Nov. 9.

rc, 29th, 5 a.m., St. Louis, Iron Mountain & Southern, Tuckerman, Ark., passenger train No. 5, which had been unexpectedly stopped, was run into at the rear by passenger train No. 17 and the rear car of No. 5 was wrecked. Four trainmen and two passengers were injured.

dr, 29th, 4 a.m., Pennsylvania Lines, Waynesburg, Ohio, a freight train was derailed by a broken rail and the engine and 13 cars were wrecked, the engine falling down a bank. The engineman was killed and one brakeman injured.

dn, 29th, St. Louis & San Francisco, Hamden, Ind. T., a freight train broke through a bridge which was undergoing repairs and which appears not to have been properly protected by flag, and the engineman was killed.

*o, 29th, International & Great Northern, Tyler, Tex., a passenger car in an excursion train was set afire by the explosion of a lamp and was badly damaged. Some of the passengers jumped out of the windows and were injured.

xc, 30th, Erie Road, Lima, Ohio, an eastbound passenger train running at high speed collided with a freight train in the yard and the fireman jumped off and was fatally injured.

unf, 30th, Southern Railway, Cordova, Ala., a freight train in or near the yard was derailed by running over a calf. Several cars were wrecked. One brakeman was killed and two other trainmen were injured.

Iceland is planning a railroad from the chief port Reykyavik, which is on a bay on the west coast, to extend eastward through a fertile alluvial plain on the south coast, formerly under the sea. The island boasts many improvements in transportation of late years. Very recently a telegraph cable to Denmark has united it with the rest of the world. There are three steamer lines to and from Denmark, and small steamers on some of the great fjords. Highways have been built so that wheeled vehicles have taken the place of beasts of burden. Several bridges cross the raging rivers which formerly could be crossed, if at all, only by ferries; and the bicycle has been naturalized. The proposed railroad will be about 45 miles long. It will not be so far north as the new Gellivara Railroad, the northernmost point of Iceland barely reaching the Arctic circle, while Narvik, the sea terminus of the Gellivara Railroad is about 140 miles further north and a distance of 300 miles north of Reykyavik.

Commissions, Take Notice!

The following extract is taken from an address recently delivered by President Arthur T. Hadley at the New York School of Philanthropy:

In the years immediately following the Civil War the whole system of American railroad rates was arranged on principles which a decently conducted store would have scorned to admit into its management. The restraints of competition had been done away with, and the managers did not see the necessity of substituting any other legal or moral restraint in its stead. In fact, they asserted a constitutional right to be free of all other legal or moral restraints. Of course this arbitrary exercise of power provoked a reaction. The state legislatures of the Mississippi valley passed the various Granger laws which were placed on their statute books from 1870 to 1875. These laws represented an attempt to reduce rates as unintelligent and crude as had been the attempts of the railroad agents to maintain rates.

Just when things were at their worst a really great man appeared on the scene of action in Charles Francis Adams, of the Massachusetts Railroad Commission. He promulgated an idea, essentially ethical in its character, which not only was of great service at the time but has been the really vital force in all good schemes of corporate regulation ever since. Mr. Adams' central principal was this: In the management of a railroad the temporary interests of the road and of its various shippers are often divergent; but the permanent interests of the railroad and of the various shippers come very much closer together than the temporary ones, and can almost be said to coincide. I cannot go into all the details of the application of this theory. Suffice it to say that during the comparatively short time when he was at the head of the Massachusetts Commission, Mr. Adams did in fact persuade not only the railroad men of that state, but the railroad men of a great many other states, to take this view of the matter; and that by his recommendation, made without any authority except the authority of common sense, he permanently removed more abuses in railroad management than all the various state statutes put together. And when the railroad commissions and other economic commissions of more recent years, disregarding the experiences of Mr. Adams, have besought over and over again for an increase of their power to make rates, and their power to prosecute offenders, and their power to keep the courts from reviewing their acts, I am reminded of the minister in the country church, who said, "O Lord, we pray for power; O Lord, we pray for power"; until an old deacon, unable to contain himself, interrupted, "'Taint power you lack, young man; it's idees!"

What Is an Engineer-Constructor?*

One prominent element of modern industrial life is bigness. We have large business corporations, combined railroad systems, extensive manufacturing concerns and comprehensive enterprises in all lines of commercial activity. Another dominant element is efficiency, which may be taken as the key word of modern business life and engineering practice. The constant aim is not cheapness in construction or equipment, but effectiveness, the greatest return for the outlay. These two elements chiefly have brought about a condition in which we have the necessity for a technical organization ready to produce large results in an effective way. Between the desire for bigness and efficiency, and its fulfilment, is the field of operation for the creative and constructive abilities of the engineer-constructor.

An engineer-constructor is an organization, and not an individual. It makes possible the most effective combination of technical theory with practical experience, and provides for the use of "team work" in connection with the designing and building of properties. Its aim is to attain the greatest economy in effort, time and money; its province is to "do" things in the most effective way. In its broadest development such an organization need not be confined to any one class of enterprise. Here is something to be built which requires for its completion a combination of conception, technical knowledge, construction experience and executive ability. Whatever it is, the engineer-constructor should be prepared to carry the proposition through from beginning to end without technical assistance from outside the organization. To be most effective, such an organization should have at its command the technical knowledge and experience of the past; the ability to analyze situations, and discover the truth from conflicting testimony; the imagination to conceive unprecedented results and courage to overcome obstacles; the ambition to improve existing systems, and the honesty to spend money without favor or graft; and finally loyalty to itself and to its client, which will protect in every way the interests of all concerned. An engineer-constructor, therefore, is nothing less than an ideal employee who has the best possible preparation, the widest experience and the natural aptitude to do in a large way the big things which the development of this country is constantly requiring. Such an organization substitutes for the isolated efforts of one or more individuals an effective combination of the aggregate abilities of a number of experts and adds the enthusiasm and inspiration which comes from the contact of fellow workers. . . .

We need for such an organization a civil engineer, electrical engineer, mechanical engineer, structural engineer, sanitary engineer, chemical engineer, gas engineer, fire protection engineer, hydraulic engineer, mining engineer, architect, industrial expert, statistician, purchasing agent, construction superintendent, operating engineer and an accountant.

An engineer-constructor is an organization in which a number of these candidates are fitted together as a mechanic would build a machine, and the efficiency of such an organization for the purpose for which it is created depends upon, (1) the perfection of its individual parts; (2) the skill with which these parts have been brought together, and (3) upon the absence of any unnecessary friction during operation. Such an organization should not be the maker or manufacturer of any equipment, nor be connected with the exploitation of any system of apparatus, nor interested in the introduction of any patented devices. In its highest stage of development it will not be connected, except in a technical way, with the financial interests which control the enterprise.

The carrying out of every big enterprise will entail nearly all of the following duties: Investigations and reconnaisance, preparation of preliminary reports, estimates of costs, estimates of probable earnings and operating expenses, surveys, preparation of plans and specifications, getting proposals and purchasing, letting contracts, field engineering, construction and erection, inspection, preparation of progress reports, record of costs, tests, operation, final reports and statistics and accounting.

Granted that such an organization of technically trained men can be brought together, what are some of the things which they may be called upon to do? A few of the things requiring such ability and experience in design and construction which occur are: Complete steam railroads, complete electric railways, electrification of steam roads, hydro-electric plants, transmission systems, power plants, gas works, electric lighting systems, industrial establishments, buildings for all purposes and public service works. In so far as an organization is prepared to effectively carry out any of these enterprises just that far will it approach its highest development.

To show the possibilities of such an organization, let us pick out a team for the building of some large proposition. Take, for instance, the design and construction of a steam railroad locomotive repair shop, involving the expenditure of from two to three million dollars. In deciding on our men, we will make a study of the qualifications of each one, and at the same time we must have a clear conception of the work each one must be familiar with in order that there be no weak spots in our line, or break in the organization. The selection of men with their chief duties will be as follows:

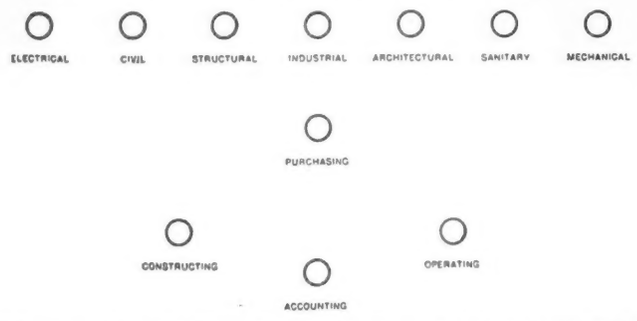
Industrial Expert	Designing layout of shops. Planning method of handling work. Arrangment of tool and transportation equipmt
Electrical Engineer	Providing power and lighting equipment. Laying out transmission systems. Planning telephone and signal systems.
Mechanical Engineer	Design of power plant. Plan of heating and ventilating. Laying out air, gas and steam systems.
Structural Engineer	Building foundations. Designing steel structures. In charge of reinforced concrete constructioon.
Architect	Designing building superstructure. Choice of fixtures Laying out landscape work.
Civil Engineer	Directing grading. Testing of soil. Construction of track.
Sanitary Engineer	Design of sewerage system. Construction of water-works. Choice of plumbing.
Purchasing Agent	Selecting markets for material. Checking bills of material. Arranging for delivery of material.
Constructing Superintendent	Organization of construction force. Consideration of time element in construction. Settling labor difficulties arising in connection with construction work.
Operating Engineer	Consideration of economies in operation. Securing reliability in operation. Insuring effectiveness in operation.
Accounting Department	Keeping payrolls. Making record of costs. Preparing progress reports.

Let us watch the play. First will come a number of preliminary studies, showing the proposed sizes, designs and relative arrangements of the buildings. Next forthcoming is a carefully prepared report, showing the advantage of the finally selected arrange-

*Extracts from a paper presented to the Electrical Section, Western Society of Engineers, Nov. 16th, 1906, by George A. Damon, Managing Engineer of The Arnold Company, Chicago.

ment, and the suggested construction of each of the buildings, together with a description of the equipment required. An important part of this preliminary report is an approximate estimate of cost, based upon a careful consideration of all the items involved in the construction. With the general layout and the preliminary report and estimate approved, the next move is to prepare the plans and specifications. . . . The plans should preferably be drawn upon one size of paper and every drawing should be numbered to correspond to the classification. A border and a standard title printed by a drafting room outfit gives a finished appearance to each drawing. Specifications can now be printed very quickly, and when at least 20 copies are required, they can be produced in this way as cheaply as by carbon copies, or the better method of blue printing from a typewritten record.

In purchasing, the engineer-constructor should find some advantage over an occasional buyer. He is in the market constantly,



Line-up of the Engineer-Constructor Team for Building a Railroad Repair Shop.

is favorably known by the manufacturers of standard equipment, and buys apparatus delivered f.o.b. cars, doing all erection work as far as possible with his own experts, and calling on the factory for assistance only when necessary. There should be the greatest unity between the engineering, the purchasing and the construction departments. It is always better to have the construction superintendent in the office while preliminary decisions are being made and bills of material are being prepared.

Throughout the entire progress of the work, systems are in use to keep all concerned informed as to each move. The construction office is advised by the home office as to the material ordered and as to the probable delivery of this material. The home office is advised as to the receipt of material on the job, as well as to the progress of the construction work, and any reports and advices as to the labor situation. To accomplish the former, copies of contracts for apparatus and orders for material are sent to the superintendent in charge of construction. Such reports and orders contain exact information as to the material covered by them, as well as to the time at which this material is expected to arrive on the work. A card system in which are entered all orders and contracts is used in the home office, and is designed to follow up and secure prompt delivery of all material and apparatus. In case of any changes in time of delivery of material, the construction superintendent is advised in advance, and is thus in position to make any alterations necessary in his programme. The importance of promptly delivering the material on the job cannot be overestimated, and the value of a system that will provide for the delivery of the materials in accordance with an approximate schedule previously arranged for will appeal to all interested in construction work.

Practically all of the material is ordered by the home office. In case, however, it is more advantageous to order small quantities at the seat of the work, such orders are issued by the superintendent, a copy of all such orders being sent to the home office, after which they are recorded and handled in all respects similar to orders issued from the office.

Records of all material received on the job are kept by the superintendent in the form of a material report. These reports are written out in a duplicate book as each shipment is received, and one copy is sent without delay to the main office. This serves to keep the home office very closely in touch with the field work, so far as the receipt of material is concerned.

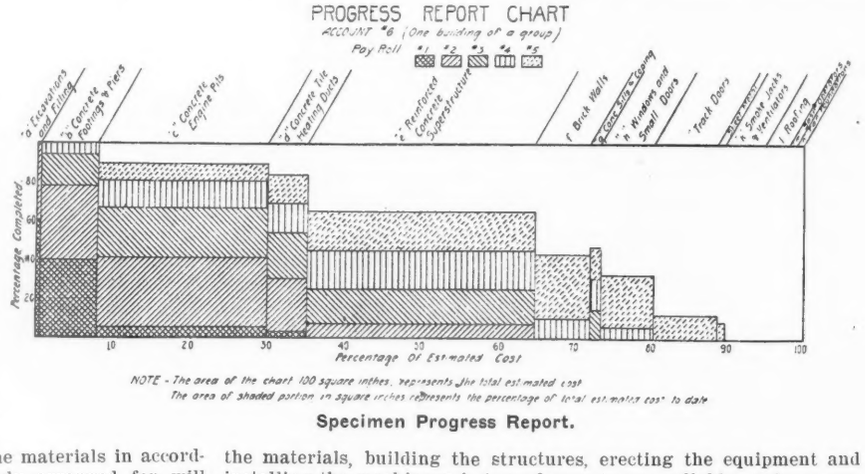
In construction work consisting of a great many items, such as will be found in railroad shops, it is very desirable to know with a fair degree of accuracy the exact progress of the work. Certain lines of the work, such as the delivery and installation of machinery, are dependent upon the progress of other work, such as the completion of the buildings and foundations. In order that this information may be always at hand, progress reports from the work are received at stated intervals, usually two weeks apart, giving in detail the progress of the work under each classification head. This information is kept in form for convenient reference, and is useful in a variety of ways. Not only do these reports keep the engineering force in touch with the progress of the work, making it possible to more efficiently insure the work coming in proper sequence, but they also provide the information necessary to make decisions as to changes in detail, in case such are found necessary after the work has been begun. These progress reports, together with a record of moneys expended for material and labor at any date, give timely information as to the actual cost of the work as compared to the estimated cost. As such reports are made on the work under each classification heading, any variation of the cost from the estimate is at once detected. This is of importance to the constructor who proposes to complete a certain improvement within a definite estimated cost, and to the client's official who may be charged with the responsibility of protecting a definite appropriation.

Progress photographs are taken of the work at intervals of about two weeks. These show at a glance not only the general progress of the work, but many construction details as well, which are of interest and value. Progress reports, charts and diagrams, while very easily obtained, and requiring but little work in their preparation, supply a great deal of valuable information, and are of worth far exceeding the trouble and expense contracted in securing them.

Although every facility is provided for keeping the main office and the construction office in close touch, it should not be understood that the engineering is done at arm's length, and that all plans and specifications are devised and completed by an engineering force in the office to be sent down to the construction superintendent on the job for his execution. A competent engineer is in charge of all construction work, and spends a certain amount of time in the field, thus putting him in close touch with the situation, and enabling him to more efficiently direct the detailed engineering work that is done in the main office.

It would be a big mistake to think that such an organization as we are outlining could be got together and perfected in its work in a short time. For our engineer-constructor it will probably take years, and it is evidently for this reason that this very inviting field is occupied by so few organizations who are really prepared to do the work justice.

If the duties of making a preliminary report, preparing a careful estimate, drawing up the plans and specifications, purchasing the materials, building the structures, erecting the equipment and installing the machinery is turned over to one reliable engineer-constructor organization on a "cost plus a percentage" plan with the privilege to the client of canceling the arrangement at any time, if the progress, quality or cost of the work should prove to be unsatisfactory, it is hard to conceive of a more effective way of getting results, and it is very probable that much of the important work of the future will be done upon this basis.



Specimen Progress Report.

The Saxon State Railroads have established the nine hour day in their shops, 4¾ in the morning and 4¼ in the afternoon. The hours for opening and closing are fixed for each shop after consultation with the representatives of the workmen. Before the three great holidays of the year the shops will close two hours earlier than usual, while the pay will be for the full nine hour day. Men employed on indispensable work in these hours will receive overtime pay, and will also be granted extra time off on some other day.

Steam Versus Electric Operation of Trunk Lines.

The following discussion of Mr. Mayer's paper, read before the American Society of Civil Engineers, on Steam versus Electric Operation of Trunk Lines (*Railroad Gazette*, Nov. 23), is contributed by Mr. Frank J. Sprague:

Not having until yesterday read Mr. Mayer's interesting paper, I find it difficult to discuss it as fully as I should like, and I shall not take up the mechanical theory of construction so ably worked out, because the paper as a whole is a plea for electric operation of a trunk line railroad by a specific method on the score of economy, and is based upon the assumption that the various claims made during the past six years for single phase operation have been justified by accomplished results, which up to the present is not a fact.

The arguments advanced seem to me somewhat vitiated by a number of statements concerning both direct current and single phase operation which will not bear critical analysis. I shall therefore content myself with some random comments on various points which have occurred to me in the preliminary reading.

First of all, let me say that I quite agree with Mr. Mayer in his general conclusion as to the necessity of higher potentials, but if his contention be that these can be effective only through the agency of single phase alternating currents, then I am quite at variance with that conclusion.

Perhaps I may be permitted to make reference to some remarks of earlier years.

Early High Tension Proposals:

In a paper before the Kansas City Electric Light Convention in February, 1890, I made the following statement: "As regards the potential, other things being satisfactory, whatever pressure is demanded in the interest of economical and effective service will be used; and means will be found, consisting mainly in care of construction, which will make its use for the purposes, and, as intended, safe and proper. We have, in these matters, to face the same questions that we have in the matter of steam pressure or of railway speed. To accomplish the larger engineering feats necessary to meet the demands of economy and commerce, we will be governed more by belief in our power to fully subordinate a good servant to our will than by our fears of its vagaries when allowed to become a master."

At the same time, to illustrate the possibilities of electric railway operation, I determined the potential necessary to handle the then existing passenger service on the Philadelphia division on the Pennsylvania Railroad, the service being rearranged so as to permit of the dispatch of cars every ten minutes. The supply was to be by direct current from a single overhead copper rod, one inch in diameter, over each track, with return through the rails. Among the solutions I found that with two stations forty-five miles apart, about only 1,800 volts motor potential was required.

It is a curious coincidence that now, sixteen years later, the proposal to use an overhead rod should be resuscitated, and also that my early proposal of a million circular-mil section of copper should be about the equivalent of the capacity of the special third rail now in use.

Mr. Mayer's proposal is, however, for a sectionalised soft steel overhead conductor, an inch and a quarter in diameter, and of a form absolutely the worst known for the transmission of alternating currents, for it offers the minimum area for unit cross section, an impedance fully nine times the resistance of the same rod to direct current, and probably eighty to ninety times that of a copper rod of the same size for direct current.

Since the date of the Kansas Convention, I have often advocated the necessity of higher potentials, and I am glad to say that not alone in alternating current work, but in direct current application, my early prophecies, repeated a year ago with an expression of readiness to undertake the responsibility of d. c. installation at 1,500 volts, even on a third rail, have, by virtue of the developments of recent months, now been brought within the reach of practical accomplishment. This would mean an increase under ordinary trunk line conditions of fully five times the distance between substations common with 600 volts, and often even the possibility of their entire elimination.

Working Conductors:

How many difficulties would disappear were we in a happy age of wireless power transmission! But we deal not with dreams but with practical realities, and among these is the physical means of getting electric energy from a central station to the moving trains. The choice is limited broadly to two general methods, the overhead system in some form, available for both alternating and direct currents, and the third rail, available ordinarily only for direct currents.

Mr. Mayer, after pointing out the shortcomings of present forms of trolley construction if used for high speed trunk line operation, somewhat naively remarks that: "As a very high and dangerous voltage must be used in the suspended conductor, it is essential to suspend it in such a way that it will never come down." I fear that we have not arrived at that millennium in railway operations when collisions, with rearing equipment, and derailments, with consequent destruction of upright structures, are no longer among the possibilities; nor are we beyond the reach of sleet formation, especially on rigid structures, or the ravages of storms of various kinds.

Of course, quite aside from the matter of expense, all conductors necessary for bringing current to a train are objectionable in many particulars, and the points with regard to each were recently well stated by Mr. Wilgus at a meeting of the Railroad Club.

The third rail offers certain hindrance to the ordinary maintenance of track, but overhead construction is inelastic, and the laying of additional tracks or changes in grade and alinement require radical and expensive alterations in permanent overhead structures.

Derailments will crush one form of conductor to the ground, but may equally well knock down the supporting structures of the other, and put all tracks out of service.

In wrecking, the third rail offers some obstruction to the throwing of the equipment to one side, but conductors overhead may interfere with the operation of crane booms.

With two or more tracks snow cannot well be piled up between them when the space is occupied by third rails, but on the other hand overhead conductors are a source of danger to trainmen, and subject to the troubles of sleet formation.

There has been a good deal of loose talk about third rail troubles with snow and sleet, complications at frogs and switches, difficulties of current collection, and the danger to employees and trespassers. Extended operation has proven that these objections are many of them largely overcome by a protected third rail properly designed with due regard to clearance lines of equipment. On the other hand, with an overhead 11,000 volt trolley there is certainly danger to the public at overhead street and highway bridges, in tunnels and at low bridges because of the possibility of rearing equipment in case of derailment or collision, and because of the frequent physical necessity of the trolley being brought within a short distance of the cars.

Then there is corrosion due to locomotive gases when steam and electric operation are maintained over the same tracks, and increased danger to men engaged in cleaning, painting, or repairing overhead structures in close proximity to high potential lines.

Again, and this seems important on high speed service, there is the possible interception of the train operator's view of the signals because dips in the railroad grade may bring overhead bridges in front of the semaphores, which likewise may be made less distinctive when having truss members for a background.

Nor can we ignore an increased element of danger to the men who have to maintain signal structures, nor the objections certain to be raised by city authorities to exposed high tension conductors.

References to Contracts:

References to contracts where single phase operation has been adopted are not always conclusive, and the inferences drawn are misleading unless the circumstances are fully known. Some of those mentioned in Mr. Mayer's paper come in this case. The Sarnia Tunnel offered an opportunity for a manufacturing company to make a demonstration of the possibilities of operation by single phase locomotives. I am quite sure it will not be claimed by engineer or manufacturer that this equipment was not well within the possibilities of direct current application, and it is certainly quite conceivable that the opportunity for first demonstration on a considerable scale had a financial value sufficiently tempting to the railroad company. As an offset to this, I can state that on a similar problem one set of absolutely comparative bids demonstrated for this particular work a marked disadvantage for the single phase equipment, both as to first cost and cost of operation.

On the London, Brighton & South Coast Road it is true that a short section is to be equipped with quite another type of single phase motor, but the reasons which have been publicly advanced, in so far as they are based on motor performance, are debatable, and if my information is reliable, the cost of installation will be a sorry criterion for comparison.

The New York & New Haven project represents a different class of installation, the replacing of steam passenger locomotives by single phase A. C. locomotives supplied from an 11,000 volt trolley line. The adoption of this equipment under the particular conditions which exist, especially the use of a common terminal with the N. Y. Central, which is to use another type of equipment, has been the subject of a good deal of discussion and some acrimonious comments, many of which had nothing to do with the system per se.

The locomotives on both these roads are of the gearless type, and within a few months there will be opportunity for making concrete comparisons of their performance, the New Haven representing the very latest single phase developments, and the Central the embodiment of D. C. plans formulated nearly three years ago, and under the then existing limitations of 600 volt operation instead of the much higher potential now practicable.

Among other comparisons will be that of the physical construction and cost of the working conductors, the former using a pro-

tected under-contact third rail, and the latter an overhead double catenary trolley carried on steel bridges spanning the tracks. Both are interesting in that they each represent construction of that type which must be adopted to come within the classification of permanent, that is, of character equal to the rest of the road. A comparison is in order, because the construction proposed by Mr. Mayer will be at least equally as costly as that adopted on the New Haven Road. An important fact is that the unit cost per mile of track for the overhead construction is fully equal to, if it does not exceed that for the third rail, despite the very high potential and the small size of the working conductor. It is proper to add that no matter how high this potential, the unit cost per mile of track for this class of construction will probably not be reduced.

Another feature of the New York Central equipment cannot be compared to a like equipment on the New Haven Road, because it does not exist on the latter, and that is the motor car service, considered by many railroad engineers and transportation officials, and applauded by Mr. Mayer as one of the indisputable good reasons for adopting electricity for suburban service.

The former road is also equipped with batteries, largely because of insurance, and not as actual necessity of operation. These could not be applied to a single phase equipment without the introduction of motor-generator sets of the full capacity of the battery discharge, as an essential of supply from the battery to the line, which in case of breakdown would eliminate the battery from use; whereas in the direct current system the intermediate machinery, that is the booster, is simply for regulation, and is of only differential capacity, hence a fraction the size of the others, and it is not essential to the supply of the current to the line in case of an emergency.

However, these two great systems will, of course, tell their own story, and after a reasonable length of service be influential in moulding decisions as to the future, but it is safe to say that however ardently the most enthusiastic engineer may preach the beauties of economy, no great trunk systems will, except for special reasons, as for example the urgent necessity of increasing capacity, adopt electricity to save money until after the tangible results have been measured on these two roads. In fact, the probabilities are that in any case it will, to quote the official of an English road, be a case of spending money, not to save it because of economy in power, but to make it.

Reasons for Adopting Electricity:

As I have often stated, there are but two broad grounds on which the adoption of electricity for trunk line operation can be justified: First, because of such demonstrated economy, due to the generation of power at large stations and reduction in the cost of locomotive upkeep, as will more than offset the interest and depreciation of that which is essential to electric operation; and, second, the possibility of an increased service of a character which cannot be gotten in steam operation—such, for example, as the handling of trains at increased speeds, or moving heavier trains at satisfactory speeds because of a greater concentration of power, or the operation of frequent motor car trains at high schedules in suburban districts and between important terminals.

But trunk line service presents peculiarities of its own, and its demands are responsible for the great awakening in the matter of higher potentials, which has led to many over-enthusiastic statements and much discussion as to the merits of single phase, polyphase, and direct current equipments.

One thing is certain, higher potentials are necessary and possible. Another is that both motor car combinations and locomotive-drawn trains must be used, the former necessarily, and the latter often under multiple unit control.

Capacity of equipment is essential, and that more than economy. How is it to be gotten? Naturally, first by increase of individual equipment, and then when this increase has reached its limit, by combining equipments. I will, therefore, briefly discuss the question of capacity.

Limitations of Design:

Neglecting for the moment the motor car, consider for a moment the simplest form of ordinary train operation. What is it that is to be replaced? Simply a steam engine, in other words a motor supplied by a local boiler, furnace and coal bin, by another motor supplied through a wire by a bigger boiler, bigger furnace and bigger coal bin. It isn't sufficient simply that these latter can be made of any desired size; in any case they are intended to supply a number of motors. What is essential, and in the last analysis vital, is that the new motor shall not only have certain mechanical advantages to the extent of eliminating the evils of reciprocating parts, but it must, above all, have capacity, measured not alone by torque or speed, but by both, and it must be of sustained character. Everything else is of tributary character.

The designer of all railway apparatus, whether for motor cars or locomotives, is handicapped by certain physical limitations which are not within his power to change. These are determined by the gage of the track, the size and number of drivers, the clearance under the motors, the length of rigid wheel base, the dead weight per wheel and the total weight per axle, to say nothing of such a trifling question as cost of construction; and it is his problem to provide within those limitations all the capacity possible.

And it is just in this particular that the single phase motor, despite an amount of experimental work, study and effort of the most persistent and able character, is sadly defective, and so far as any present knowledge goes, its defects, while not prohibitive to the extent of making an unworkable machine, are so inherent as to make it practically certain that when compared to other kinds of electric motors it is placed at a very serious disadvantage.

Comparison of Motors:

Of the three types of motors to-day in use in railway work, two, the direct current and the three-phase motors, have a continuous rate of energy input, while the single phase has an intermittent and variable rate. In the latter the attempt has been made to attain the results achieved by the variable speed direct current series commutator motor, despite the fact that there is combined in a single machine a motor and a transformer. And on the wings of high potential the advocates of single phase operation have soared to heights of eloquence from which it is necessary to descend to tangible facts.

And the first of these is, that the single phase motor, measured by identically the same rating and under like physical conditions, is only about half as good as the direct current motor, or to put it another way, the weight of the complete electrical equipment, including motors, regulators and transforming apparatus, and with like physical limitations, is fully twice that required for direct current, with, of course, a material increase in the mechanical equipment, so that the total weight of a single phase A. C. locomotive to do like service as a D. C. locomotive will easily run from 40 to 50 tons more. The reason is simple—because of the heat generated on account of lower electrical efficiency, and the impossibility of working the fields of the motors at over about one-half the magnetic flux.

Polyphase motors have the same advantage as direct current series motors in the matter of weight capacity, but are normally constant speed motors, although it is possible to arrange for half and full speed.

I have made, and so have others, many independent investigations on this subject, and the facts stated cannot be gainsaid in the present state of the art. I am, therefore, somewhat astonished to find Mr. Mayer saying that certain "locomotives use high voltage alternate currents, and have excellent speed regulations, giving practically uniform efficiency at any considerable speed, two advantages which far outbalance, especially for trunk line traffic, their inferiority in other respects," this latter being admitted as "great weight per unit of power, limited capacity, high cost, and only moderate efficiency at any speed."

This expression of inferiority is an unexpected indictment of the single phase motor, and considering a locomotive simply as a machine, he adds to this indictment by his criticism of the motor-generator type of locomotive, where a single phase motor receiving current from the trolley line drives a generator which in turn supplies direct current motors, concerning which he says, "its complications, moderate economy, inevitable high cost, and great weight are its serious drawbacks," in spite of its "excellent and economical speed regulation." As a matter of fact, the motor of such a combination can be directly supplied from a high tension line, and the weight of this type of equipment is almost identical with that of a single phase equipment, and has some possibilities which the latter has not.

A practical illustration of the bearing of this difference in capacity is the fact that although the essential weight on the drivers of the New York Central machines is about seventy tons instead of eighty-five, as on the New Haven, the individual capacity of the former is so much greater, that with equal ventilation fifteen of them will probably do the work of twenty-five of the latter.

Lack of capacity is, however, not the only feature wherein the single phase motor fails in comparison with the direct current machine. On large sizes, instead of two or four poles it has ten or twelve, and the series winding on the armature with two paths is replaced by one with as many paths as there are poles. The armature in machines of similar capacity has a large diameter and runs at a higher speed, and instead of two fixed sets of brushes there are as many movable sets as there are poles, to supply current to a commutator of larger size. The clearance between field and armature is about a quarter that of the D. C. machine, and the allowable bearing wear therefore much less. Finally, the New York Central type of machine, with its remarkable mechanical as well as electrical advantages, is impossible to direct A. C. construction and operation.

It is curious, despite frequent disproof, with what persistency certain well sounding statements reappear. Among these may be instanced that referring to possible economic variations of speed. The ordinary four-motor locomotive operated on direct current has, with proper control, three impressed electromotive forces, for each of which it has a wide automatic range of torque and speed far beyond the limits, as the sustained torque increases, of the single

phase motor, and for each of these established conditions there is a very considerable range of speed with the same torque, provided the motors are properly constructed and controlled. The result is that, as everyone of these speeds is an economic one, all variation essential for practical railroad operation is provided.

Direct Current Motor Improvements:

Comparing the present with the condition of the art about two years ago, three important and radical developments have taken place in direct current motor construction. The first is the use of the commutating pole, which has in a large measure, and certainly for any ordinary pressures, eliminated the much abused bug-bear of the commutator to such extent that, when properly constructed, it is impossible to tell by ordinary inspection whether a machine is running at high or low potential, or with large or small current, so absolutely free is it from sparking.

This has led to additional facilities in control, and the construction of motors for operation at from 1,200 to 1,500 volts, with the further possibility of operating two in series at double potential.

A third development is that illustrated by the New York Central gearless locomotives, in which the hitherto invariable practice of maintaining a fixity of relation between the armature, or rotating part, and the field magnet, or fixed part, has been abandoned, the armature being mounted directly on the axle, and the field magnets forming a part of the locomotive frame, supported by its springs, and hence movable with regard to the armature. In this construction, therefore, there are no armature or axle bearings. This machine is one of the most remarkable and satisfactory outcomes of recent work, and considering actual necessary electric additions to the mechanical equipment, it has, when designed for the conditions under which it should operate, probably the highest weight efficiency of any d. c. locomotive. Being of bi-polar construction, with a wide range of neutral brush contact, it runs practically sparklessly at all loads, is a natural 1,200 volt machine without commutating poles, and can easily be wound for a higher potential if using such poles.

Considering briefly the first cost of installation, I have shown that the weight and cost of motor equipment is much higher for the single phase a. c. system than for the d. c., and that the cost of permanent working conductors per mile of track is fully as high. The cost of central station will be somewhat greater because of the reduced capacity per weight of material of single phase generating apparatus. There remains the intermediary apparatus when extended systems are considered, namely, static transformers and rotaries for the direct current system and sub-station and car transformers for the a. c. system.

Unless there is material increase in efficiency and capacity of single phase motor equipments, it is quite likely that the interest on the increased cost of sub-stations of one kind over that of the other, and the losses in the rotaries, will be at least equaled, if not more than offset, by the increased first cost and cost of operation of the motor equipments on the a. c. system when each are installed with equal regard to permanency.

Every engineer of course hopes for, and will welcome actual advances in this art by whatever system—everything in fact which makes for increased economy, added reliability and reduced cost of operation, to the end that there may be a greater extension of electric opration, but it is absolutely essential to compare results accomplished, not merely promises of performance.

Such are some of the general facts which must be confronted in dealing with the question of electric operation of trunk lines. In conclusion, I may perhaps here quote a remark by Chief Engineer Kando, of the Ganz Company, of Europe, the advocates of polyphase motor operation, in a report recently made to his company after a trip in the United States. Referring to the question of equipment, he said: "That system will prove to be victorious which can present the most powerful locomotive, and the locomotive which will possess the greatest capacity for a given weight."

I might add to this, and say that it would seem that that type of locomotive must ultimately survive which not only has the greatest weight capacity, but also automatic response in torque and speed to the varying demands of grade and curvature.

Thermit Welding.

Thermit welding was a subject of discussion at the last meeting of the Master Blacksmiths' Association. Referring to the reliability of the thermit weld it was stated that on one road, in the period of 17 months 33 welds of engine frames were made, and they were all in service. Of these 14 were over the driving boxes and six had to be rewelded after having been in service for from three to 12 months. The frames so repaired were all of wrought-iron with one exception. This was of cast-steel. In addition to these, there were five frames welded that were broken in service, rewelded and then broken again because they were fractured at a place where it was impossible to allow the thermit collar to remain. After the second weld broke a section was cut out and reinforced with a new one of wrought-iron. During this same period above referred to 16 welds were made on cast-steel driving wheels, all of which are still in service, together with a cast-steel ferry boat casting.

Tests made with the thermit metal show that it is up to good forged iron or steel, and compared favorably with some refined iron with which it has been tested. In one case a sprue was taken and drawn down into a bar ½ in. square and tested in connection with pieces of ½-in. and ⅝-in. square refined iron. The thermit bar, with a length of 9½ in. between the jaws of the testing machine, took on a permanent set at 12,000 lbs., or 48,000 lbs. per sq. in. It elongated ¾ in. and broke at 16,300 lbs., or 65,200 lbs. per sq. in. The bars of refined iron of the same length reached their limits of elasticity at 38,440 lbs. for the ½-in. bar and 56,000 lbs. for the ⅝-in., and broke at 53,360 lbs. and 90,680 lbs. with elongations of 2¼ in. and 2 in. respectively. In this the thermit was the superior in stiffness.

In a bending test the thermit was bent double cold with no sign of cracking, which the refined iron could not do. Observation seems to indicate that what is called thermit welding is not a true weld but a braze; and in doing the work the metal of a frame should be heated to redness before the metal is poured. The two parts should also be jacked from ¼ in. to ⅜ in. apart to allow the metal to flow freely into the fracture, and it must then be drawn together while the metal is in a liquid or very soft condition so that all air holes may be closed and the metal be made dense. In further preparation for the work the surfaces of the fracture should be cleaned and the adjacent parts with which the band is to come in contact should be made bright.

High Steam Pressures in Locomotive Service.*

BY W. F. M. GOSS.

The Carnegie Institution of Washington, D. C., some three years since, became a patron of Purdue University for the purpose of promoting a research to determine the value of high steam pressures in locomotive service. The work outlined under these auspices has now been completed, and final report has been rendered the Institution. This report will soon be published. Meantime the Institution has given its consent to the publication of a preliminary statement concerning methods and results.

1. *The Tests.*—The tests outlined included a series of runs for which the average pressure was respectively, 240, 220, 200, 180, 160, 120 lbs., a range which extends far below and well above pressures now common in locomotive service. The tests of each series were to be sufficiently numerous to define completely the performance of the engine when operated at any speed and for all positions of the reverse lever possible with a wide-open throttle. So far as practicable, each test was to be of sufficient duration to permit the efficiency of engines and boiler to be accurately determined, but where this could not be done, cards were to be taken.

The first test was run February 15, 1904, and the last August 7, 1905. A registering counter attached to the locomotive shows that between these dates the locomotive drivers made 3,113,333 revolutions, which is equivalent to 14,072 miles. The completed record includes the data of 100 different tests.

2. *The Locomotive* upon which the tests were made is that regularly employed in the laboratory of Purdue University, where it is known as "Schenectady No. 2." The characteristics of this locomotive are rather generally known.

3. *Difficulties in Operating Under High Pressures.*—The work with the experimental locomotive has shown that those difficulties which in locomotive operation are usually ascribed to bad water, increase rapidly as the pressure is increased. The water supply of the Purdue laboratory contains a considerable amount of magnesia and carbonate of lime. When used in boilers carrying low pressure there is no great difficulty in washing out practically all sediment. The boiler of the first experimental locomotive, Schnectady No. 1, which carried but 140 lbs. and was run at a pressure of 130 lbs., after serving in the work of the laboratory for a period of six years, left the testing plant with a boiler which was practically clean. Throughout its period of service, this boiler rarely required the attention of a boilermaker to keep it tight. Water from the same source was ordinarily used in the boiler of Schnectady No. 2 which carried a pressure of 200 lbs. or more. It was early found that this boiler, which is of the same general dimensions as that of Schnectady No. 1, operating under the higher pressure frequently required the attention of a boilermaker. After having been operated no more than 30,000 miles, cracks developed in the side-sheets, making it impossible to keep the boiler tight, and new side-sheets were applied. In operating under pressures as high as 240 lbs., the temperature of the water delivered by the injector was so high that scale was deposited in the check valve, in the delivery pipe and in the delivery tube of the injector. Under this pressure, with the water normal to the laboratory, the in-

*A brief extract of a report submitted to the Carnegie Institute of Washington, Aug. 17, 1906. Read at the November meeting of the Western Railway Club.

jectors often failed after they had been in action for a period of two hours. The loss of tests through failure of the injector, and through the starting of leaks at staybolts, as the tests proceeded, became so annoying that, as a last resort, a new source of water supply was found in the return tank of the University heating plant. This gave practically distilled water, and its use greatly assisted in running the tests at 240 lbs. pressure.

Probably some of the difficulties experienced in operating under very high steam pressures were due to the experimental character of the plant, and would not appear after practice had by gradual process of approach become committed to their use, but the results are clear in their indication that the problem of boiler, maintenance, especially in bad water districts, will become more complicated as pressures are further increased. Since, taking the country over, there are few localities where locomotives can be furnished with pure water, the conclusion stated should be accepted as rather far-reaching in its effect.

The tests developed no serious difficulties in the lubrication of valves and pistons under pressures as high as 240 lbs., though the lubrication could not be done with a grade of oil previously employed.

With increase of pressure, any incidental leakage either of the boiler or from cylinders becomes more serious in its effect upon performance. In advancing the work of the laboratory, every effort was made to prevent loss from such causes and results were frequently thrown out and tests repeated because of the development of leaks of steam around piston and valve rods, or of water from the boiler. Notwithstanding the care taken, it was impossible under the higher pressures to prevent all leakage and the best that can be said for the data under these conditions is that it represents results which are as free as practical from irregularities arising from the causes referred to; that is, so far as leakage may affect performance, the results of the laboratory tests may safely be accepted as the record of maximum performance.

In concluding this brief review of the difficulties encountered in the operation of locomotives under very high steam pressures, the reader is reminded that an increase of pressure is an embellishment to which each detail in the design of the whole machine must give a proper response. A locomotive which is to operate under such pressure will need to be more carefully designed and more perfectly maintained than a similar locomotive designed for lower pressure, and much of that which is crude and imperfect, but nevertheless serviceable in the operation of locomotives using a lower

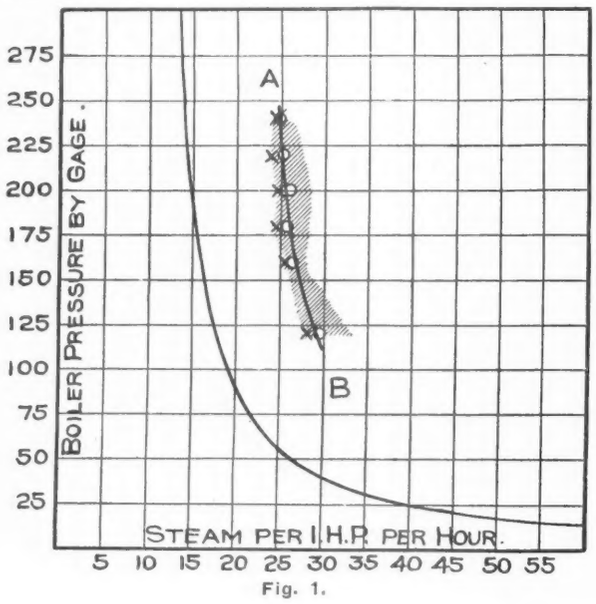


Fig. 1.

pressure, must give way to a more perfect practice in the presence of the higher pressure.

4. *The Effect of Different Pressures upon Boiler Performance* is summarized as follows:

1. The evaporative efficiency of a locomotive boiler is but slightly affected by changes in pressure, between the limits of 120 lbs. and 240 lbs.

2. Changes in steam pressure between the limits of 120 lbs. and 240 lbs. will produce an effect upon the efficiency of the boiler which will be less than 1-2 lb. of water per pound of coal.

3. The equation $E = 11.305 - .221$ H, in which E is the number of pounds evaporated from and at 212 deg. per pound of coal, and H is the pounds of water evaporated per foot of heating surface per hour, represents the evaporative efficiency of the boiler of locomotive Schenectady No. 2 when fired with Youghiogheny coal for all pressures between the limits of 120 lbs. and 240 lbs. with an average error for any pressure which does not exceed 2.1 per cent.

4. It is safe to conclude that changes of no more than 40 or 50 lbs. in pressure will produce no measureable effect upon the evaporative efficiency of the modern locomotive boiler.

5. *The Effect of Different Pressures Upon Smoke-Box Temperatures* was found to be as follows:

1. The smoke-box temperature falls between the limits of 590 deg. F. and 850 deg. F., the lower limit agreeing with a rate of evaporation of 4 lbs. per foot of heating surface per hour and the higher with a rate of evaporation of 14 lbs. per foot of heating surface per hour.

2. The smoke-box temperature is so slightly affected by changes in steam pressure as to make negligible the influence of such changes in pressure for all ordinary ranges.

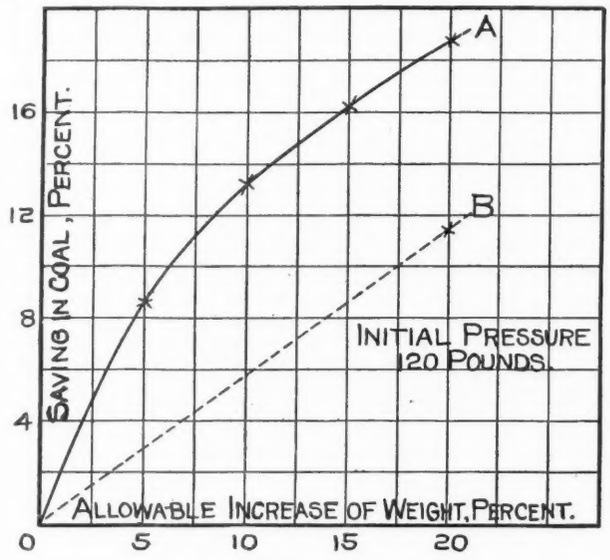


Fig. 2.

3. The equation $T = 488.5 + 25.66$ H, where T is the temperature of the smoke-box and H is the weight of water evaporated from and at 212 deg. per foot of heating surface per hour, possesses a high degree of accuracy for all ordinary pressures.

6. *The Engine Performance.*—The shaded zone upon Fig. 1 represents the range of performance as it appears from all tests run under the several pressures employed. It shows that the variation in performance for all conditions of running which are possible with a wide open throttle scarcely exceeds 5 lbs. For purposes of comparison, it is desirable to define the effect of pressure on performance by a line, and to this end an attempt has been made to reduce the zone of performance to a representative line. In preparing to draw such a line, the average performance of all tests at each of the different pressures was obtained and plotted, the results being shown by the circles on Fig. 1. Points thus obtained can be regarded as fairly representing the performance of the engine under the several pressures only so far as the tests run for each different pressure may be assumed to fairly represent the range of speed and cut-off under which the engine would ordinarily operate. The best results for each different pressure as obtained by averaging the best results for each speed at this pressure is given upon the diagram in the form of a light cross. These points may be regarded as furnishing a satisfactory basis of comparison in so far as it may be assumed that when the speed has been determined an engine in service will always operate under conditions of highest efficiency. Again the left-hand edge of the shaded zone represents a comparison based on maximum performance at whatever speed or cut-off.

In addition to the points already described, there is located upon the diagram Fig. 1 a curve showing the performance of a perfect engine with which the plotted points derived from the data of tests may be compared.* Guided by this curve representing the performance of a perfect engine, a line A. B. has been drawn proportional thereto, and so placed as to fairly represent the circular points derived from the experiments. It is proposed to accept this line as representing the steam consumption of the experimental engine under the several pressures employed. It is to be noted that it is not the minimum performance nor the maximum, but it is a close approach to that performance which is suggested by an average of all results derived from all tests which were run. Since its form is based upon a curve of perfect performance, it has a logical basis

*This curve represents the performance of an engine working on Carnot's cycle, the initial temperature being that of steam at the several pressures stated, and the final temperature being that of steam at 1.3 lbs. above atmospheric pressure. This latter value is the assumed pressure of exhaust in locomotive service.

and since it does no violence to the experimental data, it seems to be justifiable.

7. *Coal Consumption.*—Accepting the curve A. B., Fig. 1, as fairly representing the consumption of steam, the corresponding consumption of Youghiogheny lump coal for the several pressures employed is shown by Table I.

Table I.

	Coal		
	Per I. H. P., per hour.	Saved for each increment of pressure	
		Pounds.	Per cent.
240 lbs. boiler pressure	3.31	....	....
220 " " "	3.35	0.04	1.2
200 " " "	3.40	.05	1.5
180 " " "	3.46	.06	1.7
160 " " "	3.53	.07	2.0
140 " " "	3.67	.14	3.8
120 " " "	3.84	.17	4.4

The last two columns of the preceding table show the diminishing value of the fuel saving which results from a given increment of pressure as the scale of pressure is ascended. For example, increasing the pressure from 120 to 140 lbs. results in a full saving of 4.4 per cent., while a similar increment from 220 to 240 lbs. results in a saving of but 1.2 per cent.

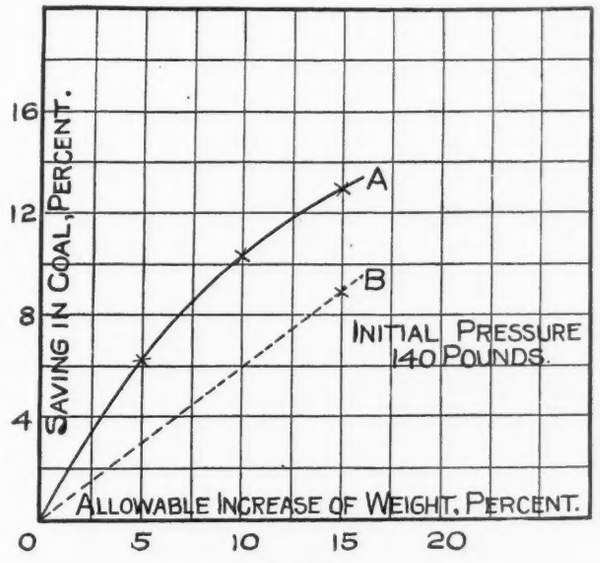


Fig. 3.

8. *Increased Boiler Capacity as an Alternative for Higher Pressures.*—Previous publications from the Purdue laboratory have shown the possibility under certain conditions, of securing a substitute for very high boiler pressures in the adoption of a boiler of larger capacity, the pressure remaining unchanged. If, for example, in designing a new locomotive, it is found possible to allow an increase of weight in the boiler as compared with that of some older type, it becomes a question as to whether this possible increase in weight should be utilized by providing a higher pressure or for an increase in the extent of heating surface. The results of tests supplemented by facts concerning the weight of boilers designed for different pressures and for different capacities supply the data necessary for an analysis of this question.

The full report presents with great elaborateness the facts which underlie the analysis. The results derived are well shown by Figs. 2 to 7, inclusive, in which the full lines represent the gain through increase of boiler pressure and the dotted line the corresponding gain through increase of boiler capacity. It will be seen that starting with pressures which are comparatively low, the most pronounced benefits are those to be derived from increments of pressure. With each rise in pressure, however, the chance for gain through further increase diminishes. With a starting point as high as 180 lbs., the saving through increased pressure is but slightly greater than that which may result through increased boiler capacity. For still higher pressures, the argument is strongly in favor of increased capacity.

The fact should be emphasized that the conclusions above described are based upon data which lead back to the question of coal consumption. The gains which are referred to are measured in terms of coal which may be saved in the development of a given amount of power. It will be remembered that conditions which permit a saving in coal will, by the sacrifice of such a saving, open the way for the development of greater power, but the question as defined, is one concerning economy in the use of fuel. It is this question only with which the diagrams, Figs. 2 to 7, deal.

There are other measures which may be applied to the performance of a locomotive, which, if employed in the present case, would show some difference in real values of the two curves (Figs. 2 to 5). The indefinite character of these measures prevent them being directly applied as corrections to the results already deduced, but their effect may be pointed out. Thus, the extent to which an increase of pressure will improve performance has been defined, but the definition assumes freedom from leakage. If, therefore, leakage is allowed to exist, the result defined is not secured. Moreover, an increase of pressure increases the chance of loss through leakage so that, to secure the advantage which has been defined, there must be some increase in the amount of attention bestowed and this, in whatever form it may appear, means expense, the effect of which is to reduce the net gain which it is possible to derive through increase of pressure. Again, in parts of the country where the water supply is bad, any increase of pressure will involve increased expense in the more careful and more extensive treatment of feed-water, or in the increased cost of boiler repairs, or in losses arising from failure of injector, or from all of these sources combined. The effect of such expense is to reduce the net gain which it is possible to derive through increase of pressure. In view of these statements, attention should be called to the fact that the gains which have been defined as resulting from increase of pressure (Figs. 2 to 7) are to be regarded as the maximum gross; as maximum because they are based upon results derived from a locomotive which was at all times maintained in the highest possible condition, and as gross because on the road conditions are likely to be introduced which will necessitate deductions therefrom.

On the other hand, the relation which has been established showing the gain to be derived through increased boiler capacity is subject to but few qualifying conditions. It rests upon the fact that for the development of a given power, a large boiler will work at a lower rate of evaporation per unit area of heating surface than a smaller one. The saving which results from diminishing the rate of evaporation is sure, whether the boiler is clean or foul, tight or leaky, or whether the feed-water is good or bad, the reduced rate of evaporation will bring its sure return in the form of increased efficiency. An increase in the size of a boiler will involve some increase in the cost of maintenance, but such increase is slight and of a sort which has not been regarded in the discussion involving boilers designed for higher pressure. Remembering then, that as applied to conditions of service, the line A is likely to be less stable in its position than B, the facts set forth by Figs. 2 to 7 may be briefly reviewed.

Basing comparisons upon an initial pressure of 120 lbs. (Fig. 2), a 5 per cent. increase in weight when utilized in securing a stronger boiler will improve the efficiency 8.5 per cent., while if utilized in securing a larger boiler, the improvement will be a trifle less than 3 per cent. Arguing from this base, the advantage to be derived from an increase of pressure is great. If, however, the increase in weight exceeds 10 per cent., the curve A ceases to diverge from B and if both curves are sufficiently extended, they will meet, all of which is proof of the fact that the rate of gain is greatest for relatively small increments of weight.

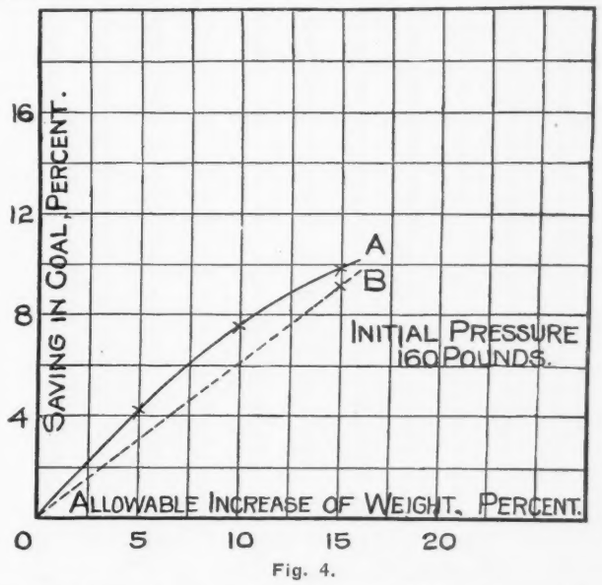


Fig. 4.

Basing comparisons upon an initial pressure of 140 lbs. (Fig. 3), the relative advantage of increasing the pressure diminished though on the basis of a 5 per cent. increase in weight, it is still double that to be obtained by increasing the capacity.

Basing comparisons upon an initial pressure of 160 lbs. (Fig. 4), the advantage to be gained by increasing the pressure over that which may be had by increasing the capacity is very slight, so slight in fact that a little droop in the curve of increased pressure

(A) will cause the difference to disappear. As the curve B may be regarded as fixed, while A, through imperfect maintenance of boiler or engine, may fall, the argument is not strong in favor of increasing pressure, beyond the limit of 160 lbs.

Basing comparisons upon an initial pressure of 180 lbs. (Fig. 5), the advantage under ideal conditions of increasing the pressure as compared with that resulting from increasing the capacity, has a maximum value of approximately one-half of one per cent. In view of the incidental losses upon the road, the practical value of the apparent advantage is nil. In view of what has been said with reference to the stability of the curves A and B, Fig. 5, constitutes no argument in favor of increasing pressure beyond the limit of 180 lbs.

Basing comparisons upon an initial pressure of 200 lbs. (Fig. 6), it appears that under ideal conditions either the pressure or the capacity may be increased with equal advantage, which in effect is a strong argument in favor of increased capacity rather than of higher pressure.

Basing comparisons upon a pressure of 220 lbs. (Fig. 7), it appears that even under ideal conditions of maintenance, the gain in efficiency resulting from an increase of pressure is less than that resulting from an increase of capacity. In view of this fact, no possible excuse can be found for increasing pressure above the limit of 220 lbs.

8. *Conclusions.*—A summary of the whole work may be stated as follows:

1. Tests have been made to determine the performance of a typical locomotive when operating under a variety of conditions with reference to speed, power and steam pressure. The results of 100 such tests have been made of record.

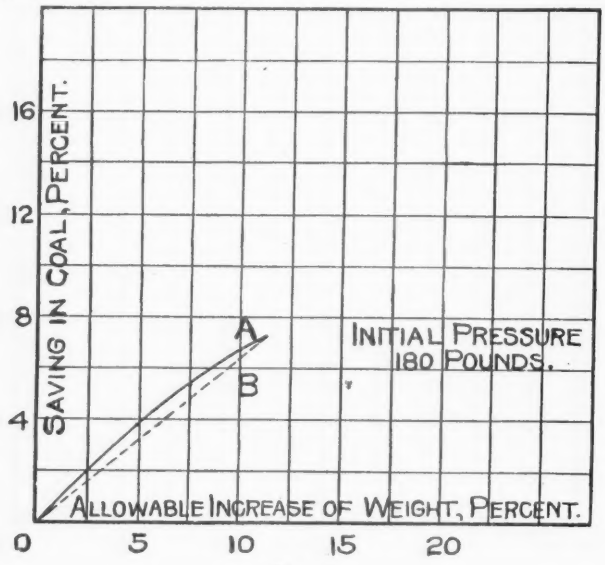


Fig. 5.

2. The results apply only to practice involving single expansion locomotives using saturated steam. They cover only such conditions as may be maintained with wide-open throttle. Pressures specified are to be accepted as running pressures. They are not necessarily those at which safety valves open.

3. The steam consumption under normal conditions of running has been established as follows:

Boiler pressure.	Steam per H. P. hr.	Boiler pressure.	Steam per H. P. hr.
120 lbs.	29.1	200 lbs.	25.5
140 "	27.7	220 "	25.1
160 "	26.6	240 "	24.7
180 "	26.0		

4. The results show that the higher the pressure, the smaller the possible gain resulting from a given increment of pressure. An increase of pressure from 160 to 200 lbs. results in a saving of 1.1 lbs. of steam per horse-power hour, while a similar change from 200 lbs. to 240 lbs. improves the performance only to the extent of .8 of a lb. per horse-power hour.

5. The coal consumption under normal conditions of running has been established as follows:

Boiler pressure.	Coal per H. P. hr.	Boiler pressure.	Coal per H. P. hr.
120 lbs.	3.84	200 lbs.	3.40
140 "	3.67	220 "	3.35
160 "	3.53	240 "	3.31
180 "	3.46		

6. An increase of pressure from 160 to 200 lbs. results in a saving of 0.13 lbs. of coal per horse-power hour, while a similar change from 200 to 240 results in a saving of but 0.09 lbs.

7. Under service conditions, the improvement in performance with increase of pressure will depend upon the degree of perfection attending the maintenance of the locomotive. The values quoted in the preceding paragraphs assume a high order of maintenance. If this is lacking, it may easily happen that the saving which is anticipated through the adoption of higher pressures will entirely disappear.

8. The difficulties to be met in the maintenance both of boiler and cylinders increase with increase of pressure.

9. The results supply an accurate measure by which to determine the advantage of increasing the capacity of a boiler. For the development of a given power, any increase in boiler capacity brings its return in improved performance without adding to the cost of maintenance, or opening any new avenues for incidental

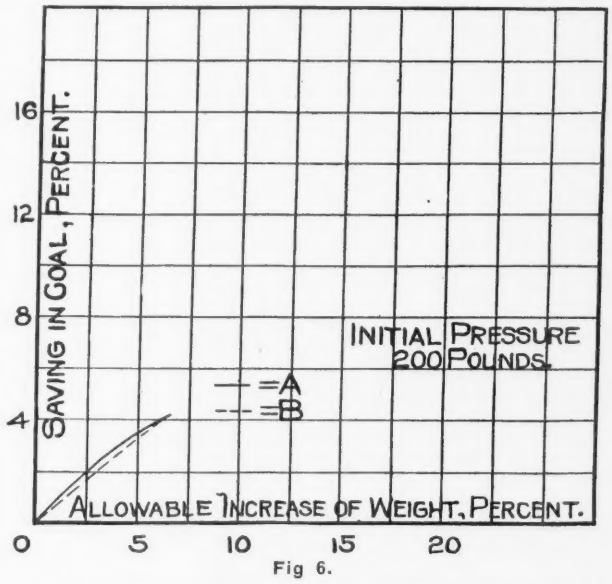


Fig 6.

losses. As a means of improvement, it is more certain than that which is offered by increase of pressure.

10. As the scale of pressure is ascended, an opportunity to further increase the weight of a locomotive should in many cases find expression in the design of a boiler of increased capacity rather than in one for higher pressures.

11. Assuming 180 lbs. pressure to have been accepted as standard and assuming the maintenance to be of the highest order, it will be found good practice to utilize any allowable increase in weight by providing a larger boiler rather than by providing a stronger boiler to permit higher pressures.

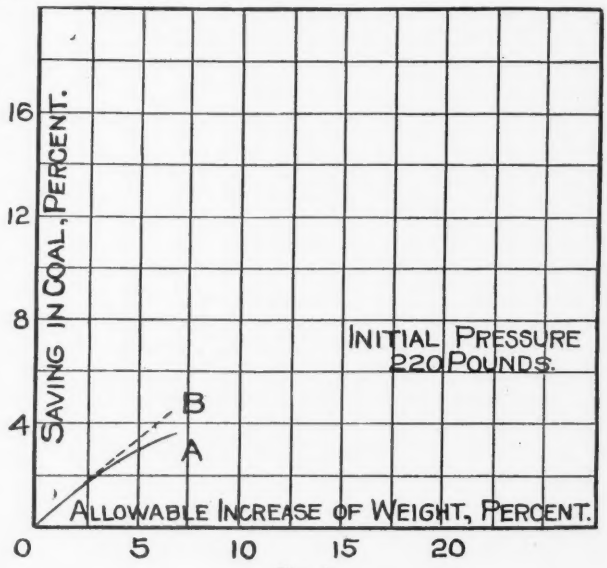


Fig. 7.

12. Wherever the maintenance is not of the highest order, the standard running pressures should be below 180 lbs.

13. Wherever the water which must be used in boilers contains foaming or scale-making admixtures, best results are likely to be secured by fixing the pressure below the limit of 180 lbs.

14. A simple locomotive using saturated steam will render good and efficient service when the running pressure is as low as 160 lbs.; under most favorable conditions, no argument is to be found in the economical performance of a machine which can justify the use of pressures greater than 200 lbs.

GENERAL NEWS SECTION

NOTES.

The Erie engineers and firemen have reached an agreement by which wages are to be advanced.

Freight trainmen on the Philadelphia & Reading have been refused their demand for a 10-hour day.

The Texas & New Orleans, according to a press despatch from Houston, Tex., has increased the pay of switchmen four cents an hour.

The New York Central firemen have received an increase of 10 per cent. in pay. The engineers have also been granted an increase. Committees of the trainmen and conductors are now conferring with the management.

The Richmond, Fredericksburg & Potomac and Washington Southern have granted an 8 hour day to all trainmen. For freight conductors there has been a 12 hour day, but all time over 8 hours is now to be paid for as overtime.

The New Orleans & Northeastern, Alabama & Vicksburg and Vicksburg, Shreveport & Pacific have increased the wages of 800 agents, clerks, engineers, firemen, conductors and trainmen, effective in some cases from October 1 and in others from November 1.

Announcement is made that the Lackawanna will increase the wages of employees in the traffic department of its ferry service from 8 to 20 per cent., the increase taking effect on December 1. The company is to extend the 10 hour day privilege, already granted to engineers and switchmen, to all trainmen.

Over $1,000,000 worth of granite awaits shipment from the quarries at Barre, Vt., said to be held up on account of scarcity of freight cars.

A new steamship line has been established between New York and Odessa in European Russia. The first steamer arrived in New York on November 24.

It is reported that in addition to the 30 miles of the Rochester division of the Erie on which electrification work is now under way, the road has decided to electrify 70 miles more in the same territory.

There is a newspaper report that a charter has been procured by Boston capitalists for a great railroad terminal at Pittsburg to cost between 15 and 20 million dollars, and a belt route from Economy on the north to McKeesport on the south.

A conference has been held between a joint committee of aldermen of Minneapolis, St. Paul, Duluth and Superior and the General Manager of the Twin City Rapid Transit Company in regard to reduced fares on the surface lines in these cities.

It is estimated that damages from recent floods in Shelby County, Tenn., will approximate $250,000. Fourteen county bridges and nine miles of levees are reported destroyed, and railroad traffic has been impeded and practically suspended on several lines.

The Texas Pipe Line Company, of which J. S. Cullinane is president, and which has by many been classed as a Standard Oil concern, has increased its capital stock from $6,000,000 to $12,000,000. It is said that the new capital has been over-subscribed in New York.

Judge Holt in the United States Circuit Court has imposed a fine of $18,000 upon the American Sugar Refining Company, which was recently convicted of accepting $26,000 in rebates from the New York Central. The defendant was given 60 days in which to prepare papers for an appeal.

The Aurora, Elgin & Chicago electric line is to do an express business out of Chicago making its charges about half that of the express companies operating on the steam routes. As it has not been able to procure a franchise in the city of Chicago for this traffic, express matter will be hauled to an out-of-town point by automobiles.

As Engine No. 634 of the Lehigh Valley, hauling a train of empty coal cars, was rounding a curve near Drifton Breaker, November 25, it plunged into an open bridge and fell 30 feet, leaving the train intact on the bank. The bridge at this point had been undergoing repairs the past week, a fact that had been overlooked by some one.

The Interstate Commerce Commission has officially announced that it is unable to make the rule that the sum of local rates shall be through rates. When complaints are made, however, the fact that the sum of the local rates is lower than the through rate will be treated as *prima facie* evidence that the through rates are excessive and unreasonable.

The new 10,000-ton steamer "Momus," one of the new boats for the Morgan Line to be put in service by the Southern Pacific between New York and New Orleans, is to make her first trip to New Orleans on December 12. She is now receiving her final equipment at the Cramp shipyards in Philadelphia.

A passenger train bound from Denver to Fort Worth over the Colorado & Southern and Fort Worth & Denver City arrived at Fort Worth on Saturday, November 24, one week after leaving Denver, having been delayed by snowstorms in thinly settled parts of the Texas panhandle. Harrowing experiences are reported as the passengers were unable to obtain food. The snow was seven feet deep in places.

A Summary of Railroad Operations for 1906.

The preliminary report of the Interstate Commerce Commission on the income account of the railroads of the United States for the year ending June 30, 1906, contains returns for companies operating 220,028 miles of line, including line operated under trackage rights, or about 99 per cent. of the mileage that will be covered by the final report. The total gross earnings of the roads shown in this report were $2,319,760,030, being equivalent to $10,543 per mile. Passenger earnings $618,555,934, or $2,811 per mile; freight earnings $1,640,942,862, or $7,458 per mile. Operating expenses were $1,532,163,153, or $6,963 per mile; net earnings were $787,596,877, being $3,580 per mile, and nearly $97,000,000 more than the corresponding amount reported for the previous year. The amount reported as income from sources other than operation was $132,624,982. This amount includes a few duplications. Adding this amount to net earnings from operation gives $920,221,859. Against this amount were charged as interest, rents, betterments, taxes and miscellaneous items the sum of $590,386,554, and as dividends the sum of $229,406,598, leaving a surplus for the year of $100,428,707. The taxes paid during the year were $68,903,288. The final report for the year ending June 30, 1905, showed a surplus of $89,043,490. The amount of dividends declared in 1906 was $34,248,605 more than that shown for the dividends of practically the same roads in 1905. This preliminary report relates to operating roads only, and does not include the statement of any dividends paid by leased lines from the income they received as rent. The dividends declared by the subsidiary leased lines for the year 1905 were about $35,750,000.

Wind Blows Passenger Train from Track.

A press despatch from Nederland, Colo., states that on November 15 the wind blew a hurricane, and a train on the Switzerland Trail Line of the Colorado & Southern was carried off the rails while crossing a trestle four miles from Cardinal. That all on board were not killed is considered a miracle. The train was made up of one passenger coach and three freight cars and only the fact that they were traveling at a good rate saved the train from being hurled into the gulch, which would have meant certain death to all. After being derailed, the engine dragged the cars into a cut just off the bridge, where the passenger coach overturned. For a time it was feared that the car would take fire from the heating stove, but the trainmen succeeded in beating out the flames before they had gained any headway.

Two-Cent Fares in Canada.

A test case for the purpose of enforcing the provision of the railroad act providing for the carrying of passengers by third class carriages at two cents per mile was brought against Charles M. Hays, general manager of the Grand Trunk Railway, before a police magistrate at Toronto, on November 21. The charge was laid under the provision of the criminal code naming a penalty for any infringement of the railroad act not provided for by the act itself. The facts of the case were not disputed. The Grand Trunk admits that it does not run third class carriages at the rate of two cents per mile, but claims that the law is inoperative and that the police magistrate has no jurisdiction as the railroad act provides a remedy for any infringement by a civil suit for damages. It was arranged that counsel should draw up a stated case for submission to the Court of Appeal, the magistrate making a nominal conviction.

Proposed Extension of Peruvian Railroad.

Halbert S. Kerr, chief engineer of the Cerro de Pasco in Peru, one of the highest railroads in the world, states that it is probable that the Cerro de Pasco will be extended some 250 miles eastward to connect with the navigable waters to the east coast of South America. A proposition is under consideration to secure government aid in extending the line. This would open up a vast territory in Peru, which has wonderful possibilities for wealth hitherto undeveloped because of a lack of transportation facilities. The pro-

posed line will run through a great agricultural country and also will open up a large expanse of timber lands. Present conditions in Peru are such that with the west slope of the Andes practically without timber the supply of the country is being shipped from the United States. On the east slope of the mountains timber is plentiful. The Cerro de Pasco leaves the Peruvian Central at Arroyo, and runs east 125 miles, through a highland valley, with a branch to the coal properties of the company. The lowest point on the railroad is 12,200 ft. above sea level and the highest 14,800 ft., while the average elevation of the road is 13,700 ft. On the Peruvian Central, which is 132 miles long, there are 52 tunnels, and 75 per cent. of the road was built through very heavy rock. This road was expensive to build, but work on the Cerro de Pasco was much easier. The principal difficulty was with marsh ground and peat beds, unexpected at such an altitude, but difficult to overcome. The construction of the coal branch was through a rugged country and on heavy grades.

Fast Run on the Panhandle.

A special train carrying members of a theatrical company, consisting of one sleeper, one coach and two baggage cars, made a run from Pittsburg to Chicago over the Panhandle (Pennsylvania Lines West, Southwest System) on November 18, 507 miles in 10 hours and 52 minutes, which is at the rate of 46.7 miles an hour. The Pennsylvania Special, which runs over the Pittsburg, Ft. Wayne & Chicago (Northwest System), makes 468 miles by that route regularly at 50.1 miles an hour. The fastest regular train by the Panhandle route makes the run from Pittsburg to Chicago in 15 hours and 30 minutes.

An Unsuccessful Train Robbery in Missouri.

A lone robber, masked and armed, robbed 20 passengers in three cars of the eastbound Chicago & Alton-Burlington passenger train No. 24 from Kansas City to St. Louis on the morning of Nov. 26 between Slater and Armstrong, Mo., and was then captured single handed by the conductor of the train. The robber boarded the smoking car as the train was pulling out of Slater shortly after midnight, relieved the passengers in that car of their valuables, got off the train at Glasgow, the next station, 25 minutes later and boarded the chair car, where he pursued the same tactics. After cleaning up the chair car he started through a sleeping car, but at this minute the conductor appeared and instead of throwing up his hands at the robber's command, knocked the revolver from the man's hand and threw him to the floor. At Armstrong, which was reached at 12.50 a.m., the robber was handed over to the authorities and taken into the station, where he remarked freely on the cowardice of the passengers and commended the nerve of the conductor. He was recognized as the same man who robbed a Rock Island train on November 9 and escaped.

Manila Railway Company.

Work has begun on the 400-mile railroad system which the syndicate recently formed by Speyer & Co., New York, plans to build in the Island of Luzon, P. I. A contract for 10,000 tons of 65-lb. rails has been awarded to the Lackawanna Steel Company. The only existing steam railroad in the Philippines was originally built and operated by the Manila Railway Company between the capital city and Dagupan. It was backed by British capital. About two years ago, however, a controlling interest in the concern was secured by the Speyer interests through whom negotiations with the insular government were carried out for the building of the new lines now under way. According to the concession the syndicate agrees to build some 428 miles of road in Luzon, including about roughly 100 miles in Albay and Ambos Camarines, the line from Manila to Batangas and Lucena with branches and several branches from the existing line of the Manila and Dagupan, branching to the east and to the west and including a line from Dagupan to San Fernando de la Union and a branch to the foot of the mountains within a few miles of Baguio.

No guaranty is asked on any of this construction. While the rates are to be based on those now enjoyed by the Manila & Dagupan, the government has the power to regulate them at any time. The existing Manila & Dagupan and all its branches give up their franchises, withdraw any claims which they may have against the municipal, provincial or insular governments, or the government of the United States, and come in under the new charter on exactly the same basis on which the new lines go in. The concession is perpetual. No mention, however, is made of competing lines, the government being free to grant franchises for such lines at any time. The company is to be taxed one-half of one per cent. on the gross earnings for 30 years; one and a half per cent. for the ensuing 50 years, and thereafter the rate is to be fixed by the government.

The concessionaires have the privilege of importing free of duty all material, etc., necessary to the carrying out of the projects. The gage of the lines will be 42 in. The President of the new company is Richard Schuster, who is a member of the firm of Speyer & Co., and the General Manager is Horace L. Higgins, who has for several years past held that position on the old Manila Railway Company.

A New Lining-Up Jack.

A new lining-up jack, combining lifting and traversing features, all worked by one interchangeable lever, is illustrated herewith. It consists of a traversing base and the jack proper. The base has a handle at one end and may be carried separately. Another handle in the form of a spur, near the top, is to carry the jack and place it in position. In lining-up, enough earth is removed from between the ties to allow the base to slide under the rail and form a firm, level foundation. The jack, being slid into the grooves of the base, is then brought up so that the foot rests under the base of the rail.

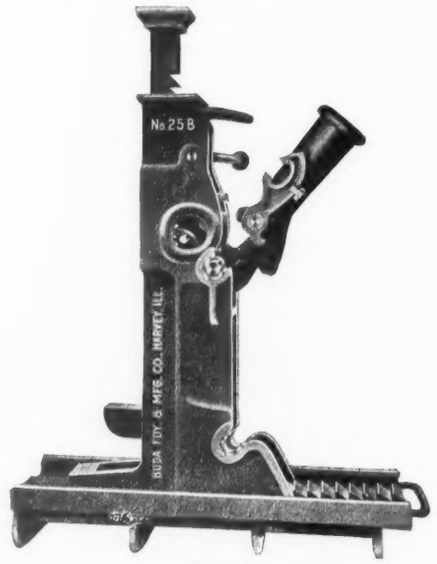


Fig. 1.

The rail is lifted by using the lever with its fulcrum resting in the upper sockets (Fig. 1), and the lifting should continue only until the ties are loosened from the earth and not far enough to allow cinders and gravel to fall under the ties. When the proper height has been reached, the lifting bar, or rack, is held in this position by a dog moved from the outside by a lever at the top of the frame on the right-hand side. When this is set, the lever is taken out and reversed and fitted into the lower sockets (Fig. 2), allowing the pawls to fall into the rack that extends along the center of the base. The track is then powerfully forced into proper line. Slightly

Fig 2.

loosening the ballast at the end of the ties makes this easier, though this is not absolutely necessary because of the capacity of the jack and powerful leverage obtained.

The jacks are used in pairs, one being placed on the outside and one on the inside of the rails. They are useful for newly laid or ballasted track, and it is also claimed that they will be found particularly valuable during the months when the section force is cut down. It needs six to eight men, with lining bars, to line up track. When the section force is very small, work of this nature

is apt to be neglected, and when the track gets in such bad shape that alinement cannot be further delayed, men must be brought from other sections to do it. But with a pair of these lining-up jacks it is claimed that the foreman and one man may go out on a hand car and line up the track where necessary as easily as they now tighten bolts. This also applies to branch lines at all seasons.

While intended primarily for lining-up, the jack may also be used for replacing cars and for general wrecking purposes. Also it may be used without the base for purposes like the ordinary ratchet jacks. Its capacity is 12 tons. It is made by the Buda Foundry & Manufacturing Co., Chicago.

Mallory Steamship Company.

The gross earnings of the Mallory Steamship Co. for ten years ended January 31, 1906, were $19,500,000, and the net earnings $3,925,000. The net earnings have shown a remarkable increase in the past four years, advancing from $450,000 in 1902 to $646,000 for the year ended last December, a gain of $200,000 or 44 per cent. in four years.

The net earnings of the company for the last five years have been as follows:

1901	$450,000
1902	450,000
1903	481,000
1904	536,000
1905	646,000

The earnings represent the balance applicable to interest and dividends after liberal charges for maintenance and repair of steamers, wharves and equipment, which have averaged $250,000 yearly for the last five years.

The net earnings for 1906 will show a substantial gain over 1905, but whether it will be more than $100,000 it is too early yet to predict. Unlike the Eastern Steamship Co., the big earning months for the Mallory lines come in the last quarter of the year, when the heavy freight movement takes place from southern ports north. Some idea of the development of the business this year may be gained by comparison of the gross business for the first nine months of 1906 with the same period last year.

Nine months:

	1906.	1905.	Changes.
Gross earnings	$2,040,000	$1,812,000	Inc. $228,000

The Mallory lines have been in operation since 1866, when the firm of C. H. Mallory & Co. was formed. Galveston, Mobile, and other southern ports were chosen for the field of operation. The first steamers of the company had a cargo capacity of 800 bales of cotton each, which contrasts with the 11,000-bale capacity of the "San Jacinto," the largest coastwise steamer in the United States (excluding the boats to Cuba and the new Morgan boats not yet in commission). The Mallory lines operate but eleven steamers, but they are all of large dimensions and capacity, and are splendidly fitted up for tourist travel. The eleven Mallory boats have a combined capacity of over 40,000 tons.

The Mallory lines have open accounts with 50 railroad companies. Of the 500,000 bales of cotton moved annually by coastwise steamers through Galveston the Mallory gets by far the largest proportion.—*Wall Street Journal.*

The following officers of the Mallory company have just been elected: Calvin H. Austin, President; H. H. Raymond, General Manager; N. H. Campbell, Secretary and Treasurer, and C. D. Mallory, Assistant Secretary.

The Pennsylvania Freight Traffic.

An officer of the Pennsylvania is quoted as follows in a Philadelphia paper:

"It is almost impossible to say what car shortage exists on the Pennsylvania because of the daily increasing amount of traffic. The demand for more cars comes from every part of the system. There does not seem to be an unusual amount of business in any one, but in all commodities. I was in Erie last week, and the business interests of that section of the State are flourishing as never before. The shipments of iron and steel products are heavy, but they are not out of proportion to the great quantity of general merchandise being shipped to the west and south. The general belief is that this business is not only going to keep up, but will increase during the next year. Railroad officers throughout the country feel confident that the general prosperity will continue. The railroad rate bill is working out as well as we can expect, and its provisions are of benefit to railroad and shipper alike."

Gently Retroactive.

The Interstate Commerce Commission, deciding an inquiry of the Illinois Central Railroad, holds that land and immigration agents, unless they are bonafide and actual employees of carriers, are not within the excepted classes specified in the free-transportation clause of the law and that providing transportation for such agents free or at reduced rates over lines of such carriers is, and *since the Act was originally passed has been, unlawful.* The ruling in Tariff Circular No. 5A is reaffirmed.

The Danville Car Company.

The Danville Car Co. has been organized with a capital of $250,000. A large tract of ground on the outskirts of Danville, Ill., has been acquired and new shops will be erected. The contract for the erection of the plant has been awarded to H. F. Vogel & Co., St. Louis, Mo. The erecting shop for railroad and electric cars will be 240 ft. x 320 ft., built of brick, with a 100 ft. transfer table at one end. The woodworking shop will be 60 ft. x 180 ft., the cabinet shop 60 ft. x 120 ft., varnish room 60 ft. x 120 ft. and the engine room 60 ft. x 120 ft. These buildings will all be wood. The blacksmith shop will be steel and brick, 80 ft. x 120 ft., the truck shop 60 ft. x 120 ft. and the machine shop 60 ft. x 120 ft.

The Illinois Traction System has tracks into the grounds at present and the Big Four and the Wabash are arranging to put in spurs. The plant will be driven by electric motors entirely. A large freight car repair shop will be put up and track space provided for a large number of freight cars. Also railroad specialties will be manufactured. It is expected to have the plant ready to repair cars by the first of February, 1907.

TRADE CATALOGUES.

Air Compressor Lubrication.—The Joseph Dixon Crucible Co., Jersey City, N. J., has published a pamphlet with this title, dealing with the causes of ignitions and explosions in discharge pipes and air receivers, the theoretical and practical functions and value of Dixon Flake Graphite as an air cylinder lubricant, methods of feeding flake graphite, secondary advantages of graphite lubrication, and the use of this lubricant in rock drills.

The Process of Concreting.—This is the title of a booklet issued by the Universal Portland Cement Co., Chicago. It is a reprint of two chapters of "Concrete, Plain and Reinforced," by Taylor and Thompson. It gives rules and formulae for grades of mixtures suited to different purposes, as well as telling what tools to use, how to make forms, instructions for the methods of mixing and laying concrete and some approximate costs.

Grinding Wheels.—The Norton Company, successor to the Norton Emery Wheel Co., Worcester, Mass., is distributing a catalogue and price list of grinding wheels, oil stones and grinding machinery. The abrasive used is alundum, made by the company in electric furnaces at Niagara Falls, N. Y.

Vises.—The Pittsburg Automatic Vise & Tool Co. sends an illustrated catalogue and price list of "Pittsburg" automatic two way vises.

Lamps.—Catalogue No. 8 of the Dressel Railway Lamp Works, New York, illustrates different styles of semaphore and other signal lamps.

Manufacturing and Business.

L. A. Wyman has been appointed to a position in the sales department of the Dayton Pneumatic Tool Co., with headquarters at Dayton, Ohio.

The T. H. Symington Co. have been given a contract by the Chesapeake & Ohio for supplying journal boxes for 2,000 50-ton coal cars, which are to be built by the Standard Steel Car Company.

M. G. Cervello, for five years engineer in the Hennebique Construction Co., Paris, France, and later with the Trussed Concrete Steel Co., Detroit, Mich., has been appointed Engineer for the Gabriel Concrete Steel Co., Detroit.

John R. Blakeslee, President of the Ajax Manufacturing Co., Cleveland, Ohio, died on November 9th. Mr. Blakeslee was born in Connecticut in 1843, and served in the Union army through the Civil War. In 1872 he went to Cleveland, Ohio, and organized the Ajax Manufacturing Co. at that place in 1894.

A. B. Gilbert has been appointed Advertising Manager of *Engineering-Contracting* and *Railway Maintenance and Structures*, published by the Myron C. Clark Publishing Co., New York. Mr. Gilbert was on the *Engineering News* for 12 years and for the last three years has been Assistant Business Manager of the *Railway Age.*

The directors of the Niles-Bement-Pond Co. have declared a stock dividend of 40 per cent. on the $5,000,000 outstanding common stock, payable January 2 to holders of record on November 30. Of the $3,500,000 additional common stock recently authorized $2,000,000 is to be issued as the above dividend, and the rest is to be sold to present stockholders.

The machine and erecting, boiler and tank shops in the locomotive shop of the Grand Trunk at Battle Creek, Mich., being built by the Arnold Co., Chicago, are under one roof, the building being 175 x 817 ft. and containing 25 erecting pits, nine boiler stalls, and nine tank stalls. The foundation work on this building is started. Other buildings of the locomotive department will follow shortly, as the intention is to complete the buildings of this department for operation before the end of 1907. Bids have been received for the boiler and forge shop of the Big Four at Indianapolis,

Ind., and the contract will be let shortly. Work on the power house, tank shop and the storehouse is being pushed rapidly. The roundhouse, power house, coaling pocket, cinder pits and sand house of the Kansas City Southern shops at Pittsburg, Kan., are nearing completion. The improvements will include a new 16-pit machine and erecting shop, a 30-ton yard crane, transfer table and reinforced concrete oil house. The Arnold Company has recently issued Bulletin No. 16, describing the Sedalia, Mo., shops of the Missouri Pacific.

Iron and Steel.

The Mexican Central will shortly be in the market for about 15,000 tons of rails. Considerable bridge material will also be ordered.

OBITUARY NOTICES.

Frederic L. Pomeroy, Freight Traffic Manager of the New York Central & Hudson River, died in Brooklyn, N. Y., on November 26, of heart disease. Mr. Pomeroy was 50 years old.

Henry S. Mitchell, Superintendent of the St. Louis & San Francisco at Fort Scott, Kan., died at Fort Scott on November 17th. Mr. Mitchell was 46 years old and had been in ill health for several years. He began railroad work in 1875 as a messenger boy on the Missouri River, Fort Scott & Gulf. He soon went to the Kansas City, Fort Scott & Memphis as a telegraph operator, and then was made a clerk in the General Superintendent's office; he was later appointed chief clerk to the General Superintendent, and for one year was also Superintendent of Telegraph. In 1888 he was appointed Superintendent of the Western division, and in 1901 went to the St. Louis & San Francisco as Superintendent of the Northern division, where he remained until his death.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad conventions and engineering societies, see advertising page 24.)

At a meeting of this club to be held December 1 a discussion of P. A. Maignen's paper on Filtration by Messrs. Ledoux, Trautwine, Leffmann and Mebus will take place.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Cincinnati, New Orleans & Texas Pacific.—Lawrence Maxwell, Jr., has been elected a Director, succeeding W. A. Garrett, recently resigned to become First Vice-President and General Manager of the Seaboard Air Line.

Illinois Central.—L. C. Fritch, who was recently appointed Assistant to the President, began railroad work in the engineering department of the Ohio & Mississippi, now part of the Baltimore & Ohio, in 1884. After being made Assistant Engineer, he was, in 1892, appointed Engineer of Maintenance of Way of that company and at the same time Chief Engineer of the Cincinnati & Bedford. Later in 1892, when the Ohio & Mississippi was absorbed, he was appointed Division Engineer of the Baltimore & Ohio. In 1899 he went to the Baltimore & Ohio Southwestern as Superintendent of the Mississippi division. He has been on the Illinois Central since February, 1904; at first he did special work for the Assistant General Manager and in 1905 was appointed Assistant to the General Manager, which position he held until his recent promotion.

L. C. Fritch.

Missouri, Kansas & Texas.—Adrian H. Joline, Chairman of the Board, has been elected President, succeeding F. N. Finney, resigned.

St. Louis & San Francisco.—C. R. Gray, Vice-President and General Manager, has been elected Second Vice-President. W. C. Nixon, General Manager, has been elected also Vice-President.

Western of Alabama.—See Atlanta & West Point.

Operating Officers.

Chicago & Eastern Illinois.—W. J. Jackson, General Superintendent, has been appointed General Manager, succeeding H. I. Miller, promoted. Mr. Jackson was born in 1859 at Toronto, Ont., and began railroad work in 1877 as a machinist's helper in the Grand Trunk shops at that place. The next year he was made freight clerk on the same road at Toronto, and in 1882 went to the Chicago & Grand Trunk as chief claim clerk at Chicago. Three years later he was made general freight foreman, and in 1890 was appointed assistant agent at Chicago. He went to the Chicago & Eastern Illinois in 1891 as assistant local freight agent at Chicago, and in 1893 was made local freight agent. He was appointed Assistant General Superintendent in 1899, and in 1903 was made General Superintendent, which position he has held until his present promotion.

W. J. Jackson.

Cincinnati, New Orleans & Texas Pacific.—Horace Baker, General Superintendent of the Southern district of the Missouri Pacific, has been appointed General Manager of the Cincinnati, New Orleans & Texas Pacific, succeeding W. A. Garrett, who resigned to go to the Seaboard Air Line.

Jonesboro, Lake City & Eastern.—A. N. Leitnaker, General Superintendent, has resigned.

Mexican Central.—The following changes in divisions have been made, effective December 1, 1906:

Mexico Division.—Mexico City to Balsas; Mexico City to San Juan del Rio, including the San Juan del Rio yard; Tula to Pachuca; Pachuca to Mexico City via Telles, and also the line Telles to Apulco, and Tepenacasco to Honey. J. J. Kertin, Superintendent, with office at Mexico City.

Aguascalientes Division.—San Juan del Rio to La Colorada, including the La Colorada yard; Guanajuato branch; Tepezala branch. J. H. Clegg, Superintendent, with office at Aguascalientes.

Torreon Division.—La Colorada to Jiminez; Dynamite branch; Gomez Palacio to Hipolito, but not including the Hipolito yard. R. I. Craig, Superintendent, with office at Jimulco.

Chihuahua Division.—Jiminez to Ciudad Juarez, including the Jiminez yard; Parral and Santa Barbara branches. W. T. Provence, Superintendent, with office at Chihuahua.

Monterrey Division.—Doña Cecilia to Hipolito, including the Hipolito yard. Charles Stich, Superintendent, with office at Monterrey.

Missouri & North Arkansas.—S. A. Nicholas has been appointed Superintendent, with office at Eureka Springs, Ark., succeeding E. O. Man, resigned.

Missouri Pacific.—See Cincinnati, New Orleans & Texas Pacific.

Traffic Officers.

Wabash.—C. H. Stinson, chief clerk to the General Traffic Manager, has been appointed Assistant General Freight Agent, in charge of fast freight lines, succeeding F. E. Signer, resigned to go to the Wisconsin Central.

Engineering and Rolling Stock Officers.

East Broad Top.—T. R. Schanks has been appointed Master Mechanic, succeeding Edgar Shellabarger, deceased.

Macon, Dublin & Savannah.—W. F. Milner has been appointed Engineer of Maintenance of Way and Structures, with office at Macon, Ga., succeeding W. C. Curd, resigned.

Union Pacific.—George F. Maitland has been appointed Resident Engineer of the Wyoming and Colorado divisions, with office at Cheyenne, Wyo., succeeding L. B. Merriam, resigned to go to another company.

Purchasing Agents.

South & Western.—W. A. Starritt has been appointed Purchasing Agent, succeeding J. F. Johnson, resigned to go into other business.

LOCOMOTIVE BUILDING.

The Grand Trunk, as reported in our issue of November 9th, has ordered 30 Richmond compound consolidation (2-8-0) type locomotives from the Locomotive & Machine Co. of Montreal for April and September, 1907, delivery, and 14 six-wheel switching (0-6-0) locomotives from the American Locomotive Co., to be built at Schenectady, for March and April, 1907, delivery. The specifications are as follows:

Type of Locomotive.	Consolidation.	Switching.
Weight on drivers	184,800 lbs.	139,500 lbs.
Total weight	211,200 lbs.	139,500 lbs.
Diameter of cylinders	22½ in. & 35 in.	20 in.
Stroke of piston	32 in.	26 in.
Diameter of drivers	63 in.	56 in.
Type of boiler	Ext. wagon top.	Straight.
Working steam pressure	210 lbs.	.....
Heating surface, total	2,925.3 sq. ft.	1,920 sq. ft.
Tubes, No.	353	264
" material	Charcoal iron.	Charcoal iron.
" outside diameter	2 in.	2 in.
" length	15 ft.	12 ft. 9½ in.
Firebox, length	8 ft. 07⅝ in.	8 " 2½ "
" width	6 " 3¼ "	3 " 4⅛ "
" material	Steel.	Steel.
Grate area	50.62 sq. ft.	27.44 sq. ft.
Tank capacity, water	7,000 U.S. gals.	5,000 U.S. gals.
Coal capacity	10 tons.	8 tons.

Special Equipment.

Air brakes	Westinghouse
Bell ringer	Grand Trunk standard
Boiler lagging	Consolidation—Wood and asbestos Switching—Sectional magnesia
Brake-beams	Grand Trunk standard
Brake-shoes	Grand Trunk standard
Couplers	Washburn or Melrose
Headlights	Grand Trunk standard
Injectors	Hancock
Journal bearings	Grand Trunk standard
Piston rod packing	United States Metallic
Valve rod packings	United States Metallic
Safety valve	Star
Sanding devices	Hand
Sight-feed lubricators	Grand Trunk standard
Springs	Consolidation—Locomotive & Mach. Co. standard Switching—Grand Trunk standard
Steam gages	Utica
Steam heat equipment	Gold
Wheel centers	Consolidation—drivers, cast-steel; others, iron Switching—Cast-iron

The Boston & Maine has ordered 10 simple consolidation (2-8-0) locomotives, 15 simple mogul (2-6-0) locomotives, 10 simple Atlantic (4-4-2) locomotives and 15 simple six-wheel switching (0-6-0) locomotives from the American Locomotive Co. The specifications are as follows:

General Dimensions.

Type of locomotive	Consolidation.	Mogul.
Weight, total	170,000 lbs.	142,400 lbs.
Weight, on drivers	148,000 lbs.	122,800 lbs.
Diameter of drivers	61 in.	63 in.
Cylinders	20 in. x 30 in.	19 in. x 26 in.
Boiler, type	Radial stay; straight top.	Radial stay, extended wag. top.
" wkg. stm. pressure	200 lbs.	
" number of tubes	326	286
" material of tubes	Charcoal iron, Worth Bros.	
" diameter of tubes	2 in.	
" length of tubes	16 ft.	11 ft. 8 in.
Firebox, length	102⅝ in.	108 7/16 in.
" width	65¼ in.	40⅜ in.
" material	Worth Bros.	
" grate area	46.5 sq. ft.	30.2 sq. ft.
Heating surface, total	2,859.87 "	1,893.2 "
Tank capacity	5,000 gals.	
Coal capacity	10 tons.	

Type of locomotive	Atlantic.	Switching.
Weight, total	156,000 lbs.	114,000 lbs.
Weight, on drivers	85,000 lbs.	
Diameter of drivers	79 in.	51 in.
Cylinders	19 in. x 28 in.	19 in. x 24 in.
Boiler, type	Radial stay, straight top.	
" wkg. stm. pressure	200 lbs.	160 lbs.
" number of tubes	326	259
" material of tubes	Charcoal iron, Worth Bros.	
" diameter of tubes	2 in.	
" length of tubes	16 ft.	11 ft.
Firebox, length	92 in.	102 in.
" width	65¼ in.	33 in.
" material	Worth Bros.	
" grate area	41.75 sq. ft.	23.5 sq. ft.
Heating surface, total	2,893.0 "	1,635.7 "
Tank capacity	5,000 gals.	4,000 gals.
Coal capacity	10 tons.	7 tons.

Special Equipment.

Air brakes	Westinghouse
Axles	Carnegie
Boiler lagging	Franklin magnesia
Brake-beams	Sterlingworth
Brake-shoes	Boston & Maine
Couplers	Tower
Headlights	Dewey
Injector	Hancock composite
Piston rod packings	Downing-Hayden Mfg. Co.
Valve rod packings	Downing-Hayden Mfg. Co.
Safety valve	Ashton
Sanding devices	Hanlon
Sight-feed lubricators (for all but switching)	Detroit
Springs	Railway Steel Spring Co.
Steam gages	American
Steam heat equipment (for Atlantic)	Consolidated
Tires—Driving wheel (for all but switching)	Midvale
" —Driving wheel (for switching)	Latrobe
" —Truck wheel (for all but switching)	Midvale
" —Tender wheel (for Atlantic)	Midvale
Wheel centers (for all but switching)	Midvale

The Canadian Northern has ordered 10 ten-wheel (4-6-0) type locomotives, and 15 consolidation (2-8-0) type locomotives from the Locomotive & Machine Company of Montreal; 15 ten-wheel (4-6-0) type and 15 consolidation (2-8-0) type engines from the Canadian Locomotive Co., and 20 consolidation (2-8-0) type locomotives from the Canada Car & Foundry Co. for 1907 delivery.

CAR BUILDING.

The Tidewater is in the market for 300 gondola cars of 100,000 lbs. capacity.

The Grand Rapids & Indiana is in the market for eight or ten passenger coaches.

The Trinity & Brazos Valley is asking bids on 200 flat cars of 60,000 lbs. capacity.

The Boston & Maine is reported to have ordered 1,000 box cars from the Pullman Company.

The Chicago, Burlington & Quincy will be in the market for about 3,000 freight cars in the near future.

The Milwaukee Refrigerator Transit Co., Milwaukee, Wis., is reported as in the market for 200 refrigerator cars.

The Chicago & Eastern Illinois has ordered three buffet library cars and three chair cars from the Pullman Company.

The Hocking Valley, it is reported, has ordered 1,000 steel underframe gondolas from the Ralston Steel Car Company.

The Manufacturers Junction Railway is asking bids on six box cars of 60,000 lbs. capacity, and four flat cars of 80,000 lbs. capacity.

The Georgia Railway & Electric Company, Atlanta, Ga., it is reported, is about to order 25 street cars, of which nine will be semi-convertible.

The La Crosse & Southeastern, it is reported, has ordered three 36-ft. box cars of 50,000 lbs. capacity from the Hicks Locomotive & Car Works.

The Buffalo, Rochester & Pittsburg, as reported in our issue of October 26, has ordered from the American Car & Foundry Co. 500 steel hopper cars of 100,000 lbs. capacity.

The Canadian Northern has ordered for 1907 delivery 1,500 box cars, 12 day coaches, six baggage cars and six mail and express cars from Rhodes, Curry & Co.; 100 flat cars, 200 stock cars, 15 cabooses, 16 day coaches, four baggage cars and four mail and express cars from the Crossen Car Mfg. Co.; 200 Hart convertible cars to be built by the Canada Car Co.; four day coaches, two parlor cars, three sleeping cars and two diners from the Barney & Smith Car Co. These orders include the cars reported in our issue of August 31st. The equipment is to be distributed to the Canadian Northern, the Canadian Northern Ontario, the Canadian Northern Quebec, and the Halifax & Southwestern.

The Texas Company, as reported in our issue of November 23, has ordered 275 steel underframe tank cars of 8,000 gallons capacity, weighing 80,000 lbs., and 25 steel underframe tank cars of 12,000 gallons capacity, weighing 100,000 lbs., from the American Car & Foundry Co., for September to November, 1907, delivery. The smaller cars will measure 28 ft. 1½ in. long, inside measurements; 33 ft. long, over all, and 82½ in. inside diameter. The larger cars will measure 33 ft. long, inside measurements; 37 ft. 10½ in. long, over all, and 93¼ in. inside diameter. Both types of cars will be 8 ft. wide over all. The special equipment includes:

Bolsters	3-10-in. web plates conforming to tank
Brake-shoes	Am. Car & F'dry Co. standard M.C.B. cast-iron
Brakes	Westinghouse Automatic
Couplers	M. C. B. Automatic cast-steel
Draft rigging	Friction draft gear
Dust guards	Bass wood or white pine
Journal boxes	M. C. B. cast-iron
Springs	M. C. B. Class "C" and "D"
Trucks	M. C. B.

RAILROAD STRUCTURES.

ABERDEEN, S. DAK.—The Minneapolis & St. Louis has plans ready for a brick passenger station 70 ft. x 100 ft., to cost $25,000.

ANTIGO, WIS.—The Chicago & North-Western is to put up a new station here to cost $25,000.

CANON CITY, COLO.—The Denver & Rio Grande has plans ready for a brick passenger station to cost $40,000.

COFFEYVILLE, KAN.—Work is to be started this year on a combined passenger and freight station for the Missouri, Kansas & Texas. The proposed structure will be of brick, two stories high, and will contain a passenger room 75 x 32 ft., freight room 60 x 32 ft., and baggage room 33 x 32 ft.

COVINGTON, KY.—The Louisville & Nashville will put up a new passenger station here.

KNOXVILLE, TENN.—The Southern Railway, it is reported, has given a contract to Borches, Waldrep & Co., of this place, to put up new shops, to cost $200,000.

MERRITTON, ONT.—A steel bridge is to be built by the Niagara, St. Catharines & Toronto Railway at this place.

MINNEAPOLIS, MINN.—According to local reports the Northern Pacific, the Great Northern, the Minneapolis, St. Paul & Sault Ste.

Marie, and the Wisconsin Central will jointly construct new freight terminals at this place. Sixteen square blocks have been bought in the northwestern section of the city as a site for yards. Plans for this work have been under way for some time.

Moncton, N. B.—Bids are wanted December 10th by L. K. Jones, Secretary of the Department of Railways and Canals at Ottawa, for putting up locomotive shops at Moncton for the Intercolonial Railway.

New York, N. Y.—The Board of Estimate and Apportionment has ordered the immediate buying of land in Manhattan at a cost of about $4,000,000, and in Brooklyn at a cost of $300,000, for approaches for the Manhattan bridge.

Omaha, Neb.—An officer writes that the new shops to be put up by the Union Pacific at this place are to be built in the form of an L. The coach and cabinet shop portion is to be 21 ft. high from floor to bottom chord of roof truss, 178 ft. x 342 ft., and car repair shop portion 26 ft. 6 in. high, 150 ft. x 342 ft. The approximate cost of the building without equipment will be $200,000. The building is to have steel skeleton with brick walls. Contracts have been let to B. J. Jobst, of Omaha, Neb., for work above water line, and to J. W. Towle for pile driving. The balance of the foundation work has been done by the company's forces.

Ottawa, Ont.—The Canadian Northern Ontario has been authorized to build four bridges over the outlet to Lake Couchiching.

Pittsburg, Pa.—The Wabash, it is said, is planning to replace many wooden structures with steel bridges on the West Side Belt and the Wheeling & Lake Erie roads, for which contracts are to be let shortly. The proposed bridges are to be made for two tracks, preparatory to double-tracking between Pittsburg Junction and Huron Junction, 124 miles.

Roanoke, Va.—The Tidewater, it is said, has given a contract to E. Tatterson for putting up a freight house here, to cost $50,000.

Two Harbors, Minn.—The Duluth & Iron Range has given a contract to the Barnett & Record Company, of Duluth, for rebuilding its ore dock No. 5 at this place. The contract calls for the completion of the work by the opening of navigation next spring.

Wichita, Kan.—The Missouri Pacific has started work on a roundhouse, car shops, repair, equipment and machine shops here.

Winnipeg, Man.—The city authorities are considering the question of putting up a steel bridge over the Red river to St. Boniface.

Application has been made by the Canadian Northern for permission to build a roundhouse here.

A steel bridge is to be built over the Canadian Pacific tracks, to cost about $200,000.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

Astoria & Columbia River.—See Corvallis & Eastern.

Atchison, Topeka & Santa Fe.—See Gulf, Colorado & Santa Fe under Railroad Corporation News.

Baltimore, Frederick & Hagerstown (Electric).—A mortgage has recently been filed by this company with the Fidelity & Deposit Co. of Maryland to secure funds to complete its proposed electric road from Hagerstown to Baltimore, 78 miles. (May 18, p. 149.)

Beaverton & Willsburg.—Incorporated in Oregon with $75,000 capital by W. Crooks, H. T. Conner and others, of Portland. The company proposes to build a line from Beaverton, on the Oregon & California (Southern Pacific) northeast to Willsburg, East Portland, about eight miles. This is said to be a project of the Southern Pacific.

Bessemer & Lake Erie.—In order to double the ore carrying capacity from Conneaut Harbor to the Pittsburg district an amount of $1,000,000, it is said, is to be spent to double track this road.

Buffalo & Lake Erie Traction.—A consolidation of the Buffalo & Lake Erie Traction and the Dunkirk & Fredonia Railroad has been incorporated in New York under the above name with a capital of $4,070,000. The directors include Joseph B. Mayer, of Buffalo; Alexander Keogh, of New Rochelle; P. C. Shutrum and others, of New York City.

Burrs Ferry, Browndel & Chester.—This company, organized last spring, has completed surveys from Rockland, Tex., east via Browndel for a distance of 56 miles, and has eight miles of road completed from Rockland to Aldridge. Contracts will soon be let for additional work. The proposed route is from Burrs Ferry, on the Sabine river in Newton County, west of Chester on the Missouri, Kansas & Texas, in Tyler County, about 80 miles. The road is ultimately to be extended from its eastern terminus towards Alexandria into a timber section of Louisiana. (See Construction Record.)

Canadian Northern Ontario.—This road, which is part of the Mackenzie-Mann System, and was formerly known as the James Bay Railway, recently started train service on its new line from Toronto north to Parry Sound, 149 miles, providing an additional route for traffic from the upper lakes south to Toronto and the East. It is proposed to extend the line northwest to Sudbury, thence north into a mineral section on which work has already been begun. The road has many sharp curves and grades on the section north of Lake Simcoe. (See Canadian Northern Oct. 19, p. 106.)

Cananea, Yaqui River & Pacific.—This company has obtained a concession from the Mexican Government to build a line from a point on the Naco & Cananea railroad to Imuris on the Sonora railroad. The terms of the concession call for completion of the line within 18 months, and it grants to the company exclusive rights for 10 years to the traffic of the territory for about 20 miles on each side of the proposed line.

Chewahwah Valley.—Incorporated in the state of Washington with $1,000,000 capital by H. F. Albers, of New York; T. E. Ellis and J. S. Jurey, of Seattle, and W. R. Woodward, of Leavenworth, Wash. The company proposes to build a line from a point on the Great Northern in Chelan County north to a point in the same county, about 30 miles.

Chicago & Eastern Illinois.—The work of double-tracking this road is to be pushed to completion. Only 52 miles remain to be double-tracked, the section from Tuscola southwest to Pana.

Chicago, Iowa & Northwestern.—This company proposes to build a line from Anamosa, Iowa, on the Chicago, Milwaukee & St. Paul, the Chicago & North-Western and the Chicago, Anamosa & Northern, northwest via Waterloo to Austin, Minn., about 160 miles, and thence into northwestern Minnesota to points not yet determined. To carry out this work it has incorporated the Empire Railway Construction Co., with office at Waterloo, Iowa, in which George E. Armstrong, Jr., William Bristol and G. H. Myers, of New York, are interested.

Chicago, Milwaukee & St. Paul.—Contracts are reported let to Michael Jennings, of Spokane, Wash., for building 150 miles of this company's proposed line from Whitehall, Mont., east to Harlowton, the base of operations being Jefferson Island. Work will begin as soon as men and material can be assembled. Much of this is heavy grading, together with the boring of a number of tunnels. The longest tunnel is to be 576 ft. long, and the shortest 160 ft. The contract calls for the completion of the work in 14 months.

Chicago, Rock Island & Pacific.—Surveys are reported being made by this company for a line from a point near Watanga, Okla., on its main line, northwest, about 60 miles, into Dewey County north of the Canadian river.

Columbia River & Oregon Central.—See Union Pacific.

Columbus & Southern.—According to reports from Columbus this road has been bought by E. B. Bingham, of Toledo, representing New York and Philadelphia capitalists. The company operates 34 miles of road from Wyandotte, Ohio, on the Cincinnati & Muskingum Valley, south to South Bloomingville. It is the intention of the new owners to extend the road northeast to Lancaster, about 15 miles.

Corvallis & Eastern.—It is reported that President A. B. Hammond, of this company and of the Astoria & Columbia River, announces that the C. & E. will be extended from its eastern terminus at Idanha, Linn County, Oregon, east across that state to a point on the Ontario river, probably at Ontario, and that the Astoria & Columbia River is to be extended from its southern terminus at Seaside south along the coast to a point in Tillamook County. These projects aggregate about 350 miles.

Delaware & Eastern.—Train service was started on this road November 17. The line runs from East Branch, N. Y., on the New York, Ontario & Western northeast to Arkville on the Ulster & Delaware, 45 miles. (Nov. 23, p. 145.)

Detroit, Flint & Saginaw (Electric).—The Detroit Trust Co. was recently appointed receiver of this 12 mile road, which runs from Saginaw to Frankenmuth, Mich. It is said that the line is to be extended to Flint, an additional 20 miles.

Eastern Texas.—According to reports this company, operating a road 30.3 miles from Lufkin, Texas, west, is planning to build an extension from its present western terminus at Kennard west to Crockett, on the International & Great Northern, about 15 miles.

Great Northern.—Construction work on the branch line from Wenatchee, Wash., northeast to Oroville, 140 miles, is to be begun next month, according to a statemenet of an officer of the road. While it is not said where the work will begin, it is stated that three contracts have been let between Orondo and Wenatchee, also from Oroville south. Wenatchee will be the base of construction for the southern end of the line.

Gulf, Colorado & Santa Fe.—Surveys are reported being made by this company for an extension of its Beaumont line from the

northern terminus at Center, Shelby County, Tex., north for a distance of 20 miles.

See same road under Railroad Corporation News.

GULFPORT & NORTHWESTERN.—Incorporated in Mississippi, with officers as follows: Edward Hines, of Chicago, President; E. F. Barthe, First Vice-President; A. McAlpin, Second Vice-President; F. A. Weyerhaeuser, of St. Paul, Minn., Treasurer; C. F. Wiehe, Secretary; S. J. Cusson, General Manager; V. A. Griffith, of Gulfport, General Counsel. The company proposes to build a line from Gulfport, on the Louisville & Nashville and the Gulf & Ship Island, northwest to Vicksburg, 175 miles. Contracts have been made with the Gulf & Ship Island for terminals at Gulfport and wharf privileges. Rights of way have been secured from Gulfport to Poplarville.

MALAD VALLEY.—See Union Pacific.

MINIDOKA & SOUTHWESTERN.—See Union Pacific.

NORTHERN PACIFIC.—Surveys are being made for a line from De Smet to St. Regis, in the Coeur d'Alene country, 72 miles, for the purpose of making material changes in the Coeur d'Alene branch, a portion of which is to be made the main line of the road. This line will be connected with the new line which has just been run from Paradise to St. Regis. It will make the main line about 28 miles longer than the present route, but there will be no heavy grades.

This company has completed laying double track from Fargo, N. Dak., east to Glyndon, Minn., and it is now in use. The company now has its line double-tracked from Casselton, N. Dak., east to Glyndon, 29 miles.

OKLAHOMA NORTHERN.—Incorporated in Oklahoma with $1,000,000 to build a line from Thomas, on the St. Louis & San Francisco, northwest to Taloga, 35 miles. The incorporators include A. A. Patterson, of Benton Harbor, Mich.; C. D. Nichols, of Oklahoma City; F. L. Black, of Taloga, and others.

OREGON & WASHINGTON.—See Union Pacific.

OREGON RAILROAD & NAVIGATION.—See Union Pacific.

OREGON, WASHINGTON & IDAHO.—See Union Pacific.

PEORIA RAILWAY TERMINAL.—Incorporated in Illinois with $1,000,000 capital to build a line from Peoria south through Pekin to a point in Tazewell County. The Board of Directors includes: T. A. Grier, F. H. Smith, H. F. Steele and William J. Jack, of Peoria, and W. J. Conzelman, of Pekin.

ST. JOSEPH & GRAND ISLAND.—This company is asking bids to build a branch line from Stouts, Kan., north to Highland, seven miles.

SAN SABA VALLEY.—This company, which was incorporated in Texas last summer, to build a line from Antelope Gap, on the Gulf, Colorado & Santa Fe, west to Crothers, 50 miles, has completed surveys from Antelope Gap to San Saba, 20 miles, and expects to begin construction work about the first of next year. W. S. Haywood, of Jefferson, Tex., is Chief Engineer. (June 15, p. 175.)

SOUTH OMAHA & WESTERN.—See Union Pacific.

SPRING, HAZEL & TRINITY RIVER.—This company has been organized in Texas to build a line from Spring, on the International & Great Northern, east to a point on the Trinity river, near Liberty. The company proposes to buy the 5½ miles of railroad and the rights of way of the Huik-Blain Lumber Co., from Hazel, on the Houston, East & West Texas, west to the San Jacinto river, which is to be extended to Spring; also east from Hazel to the Trinity river, traversing about 30 miles of timber lands. The office of the company is at Hazel, Montgomery County.

TECUMSEH & NORMAN TRACTION.—Incorporated in Oklahoma with $1,000,000 capital by S. P. Mitchell, G. C. Standford, M. H. Tennison and J. T. Butler, of Tecumseh, and G. Weed, of New York. The company proposes to build an electric line from Tecumseh west to Norman, about 40 miles.

TEMISKAMING & NORTHERN ONTARIO.—The Province of Ontario has again filed a request at Ottawa for a Federal subsidy of $6,400 per mile on new mileage for this road, which is being built from New Liskeard north 100 miles by the Ontario Government to a junction with the Grand Trunk Pacific at Abittibi.

THE MINNEAPOLIS & ST. PAUL SUBURBAN.—This company, which is a subsidiary of the Twin City Rapid Transit Co., has bought the Robbinsdale electric line, the last remaining independent line running out of Minneapolis, operating about 10 miles north and west of Minneapolis. A. S. Robbins, former owner of the line, had secured franchises from Anoka and Oaseo, two prosperous towns of Minneapolis, and was about to extend the line. Its purchase by the Twin City interests means greater extensions than originally planned. During 1907 several of the lines north and west of Minneapolis will probably be extended and improved.

TOLEDO & INDIANA (ELECTRIC).—Preliminary surveys have been completed by this company for its proposed extension from Bryan, Ohio, west to Waterloo, Ind., 30 miles; also for a branch line from Delta, Ohio, southwest via Napoleon to Defiance, an additional 30 miles.

TONOPAH & TIDEWATER.—This company, which is building a line from Ludlow, Cal., where a connection is made with the Atchison, Topeka & Santa Fe, north to Bullfrog, Nev., 170 miles, has opened the first 75 miles of its road from Ludlow to Front.

TOPEKA & NORTHWESTERN.—See Union Pacific.

UNION PACIFIC.—The annual report of this company issued on November 27th sums up construction work as follows: The mileage of the three railroads known as the Union Pacific Railroad and auxiliary companies at the end of the fiscal year was 5,664 miles, an increase of 76 miles. The Minodoka & Southwestern was opened for traffic in September, 1905, from Minodoka, Idaho, to Twin Falls, 59 miles. The projected route of this company extends across Snake river to a point on Salmon river, a total of about 85 miles. The Yellowstone Park Railroad from St. Anthony to Morrisville, Idaho, 16 miles, was opened for traffic in June, 1906. The projected route of this company from St. Anthony to the boundary of Yellowstone Park has a total length of 70 miles.

The following lines have been projected and are in course of construction by the following named companies or by companies organized in their interest:

Union Pacific.—A line from O'Fallon, Neb., to Northport, about 114 miles, all graded, and of which about 19 miles of main track are laid. A line from Stromsburg to Central City, Neb., about 23 miles, which will probably be completed about January, 1907, and which will considerably shorten the distance between points on the Manhattan and Beatrice branches and points west of Central City. A line from Thayer, Wyo., to the coal mines in Horse Thief Canon, about 12 miles, and a line from the Washington mine, Colorado, to Grant coal mines, about seven miles, will probably be completed by the end of the current calendar year.

Oregon Railroad & Navigation.—An extension of the Elgin branch from Elgin, Ore., to Joseph, about 63 miles, of which about 18 miles are graded. An extension of the St. Johns branch from St. Johns to a point near Troutdale, 20.15 miles, which will form a loop with the present main line to Portland; about three miles of this line are graded.

Malad Valley.—The remaining part of this line, from Garland, Utah, to Malad, Idaho, 31.83 miles in length, was completed during the year and put in operation July 1, 1906.

South Omaha & Western.—The construction of this double-track cut-off line from South Omaha to Lane, Neb., 11.6 miles, which will shorten the distance between South Omaha and Council Bluffs and points west of Lane 8.94 miles, is progressing.

Topeka & Northwestern.—This company was organized to build a line from Menoken to Marysville, Kan., about 70 miles. The line from Menoken to Onaga, Kan., about 38 miles, was opened for traffic February 5, 1906.

Columbia River & Oregon Central.—This company's line from Arlington to Condon, Ore., 45.31 miles, was leased to the Oregon Railroad & Navigation Company, July 1, 1906.

Oregon & Washington.—This company was incorporated to build the line from Portland, Ore., to Puget Sound, about 230 miles. The acquisition of ample terminal properties in the best locations is well advanced in both Tacoma and Seattle, and work on this line will be actively prosecuted when pending applications for the necessary municipal franchises shall be granted.

Oregon, Washington & Idaho.—Under an agreement for construction of a joint line with the Northern Pacific from Texas City, Wash., a point opposite Riparia on the Snake river, to Lewiston, Idaho, about 72 miles, the Oregon, Washington & Idaho was incorporated for the construction of this road. About 15 miles of main track are laid, about 32 miles additional are graded and the entire line will be completed during the next year.

Since the close of the fiscal year, additional companies have been incorporated. The cost of lines in course of construction, of other lines projected, and of additional equipment, will involve an outlay of about $50,000,000.

VALLEJO & NORTHERN.—Incorporated in California with $2,500,000 capital by Melville Dozier, Jr., and George S. Lackie, of Oakland, T. C. Gregory, of Suisun, and others, to build a line from Woodland, on the Southern Pacific, southwest via Winters, Vacaville, Fairfield and Napa Junction to Vallejo, in Solano County, 70 miles. The office of the company is to be at Vallejo.

VANDALIA.—The Board of Public Works of Indianapolis, Ind., has granted this company permission to lay 12 additional tracks at grade, across Belmont avenue, in addition to the eight tracks now in use. This is somewhat of a compromise as the railroad asked the city to vacate Belmont avenue, while the city wanted the railroad company to elevate its tracks.

Western & Gulf.—Surveys are being made and rights of way secured by this company, which was recently incorporated in Georgia to build a line from Hawkinsville to Americus and Dawson, about 85 miles. Contracts for construction work are to be let early next year. Crawford Wheatley, of Americus, is President. (Nov. 9, p. 130.)

Wheeling & Lake Erie.—According to reports from Pittsburg this company will spend $3,500,000 double-tracking its road between Pittsburg Junction and Huron Junction, 124 miles.

Yellowstone Park Railroad.—See Union Pacific.

Yosemite Valley.—An officer writes that operation on a 12-mile extension from Pleasant Valley southeast to Bagby was commenced November 15, making 48 miles now under operation. The company is also building an additional 30 miles, which it expects to have completed by March of next year.

RAILROAD CORPORATION NEWS.

Atchison, Topeka & Santa Fe.—See Gulf, Colorado & Santa Fe.

Atlanta, Birmingham & Atlantic.—The Brunswick Steamship Company, organized in the interest of the Atlanta, Birmingham & Atlantic, has begun service between New York and Brunswick, Ga., with the freight steamer "Satilla." A second steamer, the "Ogeechee," is to be put in service December 15, and early in 1907 two other steamers, the "Okmulgee" and the "Ossabaw." These four boats will run in a regular semi-weekly service. On January 5, the passenger steamer "Brunswick" will leave New York for Havana, Cuba, calling at Brunswick both going and returning, thereafter sailing semi-monthly. C. L. Dimon is Vice-President and General Manager of the Brunswick Steamship Company, with offices at 32 Broadway, New York.

Atlantic Coast Line.—See Macon, Dublin & Savannah.

Buffalo & Lake Erie Traction.—The Buffalo & Lake Erie Traction Company was formed on October 29 as a consolidation of the Buffalo, Dunkirk & Western and the Lake Erie Electric Traction, the last named company being a consolidation of the Lake Erie Traction Company and the South Shore Suburban Railway. The Dunkirk & Fredonia (Electric) has now been merged into the Buffalo & Lake Erie Traction Company, the capital stock of which has been consequently increased from $3,900,000 to $4,070,000. The Dunkirk & Fredonia owns about seven miles of track in Fredonia, New York.

Chicago, Indianapolis & Louisville.—The American Trust & Savings Bank, Chicago, is offering at 96½ and interest $1,500,000 first mortgage 4 per cent. bonds of 1956, of the Indianapolis & Louisville, which is building 60 miles of road as an extension of the main line of the Chicago, Indianapolis & Louisville from a point near Quincy in Putnam County, Ind., to Shirley Hill, in Sullivan County. The bonds are part of an authorized issue of $6,000,000 guaranteed principal and interest by the C., I. & L., which is to lease the line for 99 years, and the balance is to be issued for extensions and betterments at the rate of $30,000 per mile after the above 60 miles of road are built.

Cincinnati, New Orleans & Texas Pacific.—A semi-annual dividend of 2½ per cent. has been declared on the common stock. The last payment, in June, was 3 per cent. In 1905, 3 per cent. was paid in June and 2 per cent. in December. Previous payments were 2 per cent. in September, 1904, and 2 per cent. in December, 1903.

Consolidated (N. Y., N. H. & H. Electric Lines.)—This company has bought some 72 miles of trolley lines in northern Rhode Island and southern Massachusetts, including the Milford, Attleboro & Woonsocket Street Railway, operating 30½ miles of line, the Woonsocket Street Railway with 22 miles of line, the Providence & Burrillville Street Railway with 10 miles and the Columbian Street Railway (Pascoag), 9½ miles. All the stock, with small exceptions, of the latter three companies is taken over, and a controlling interest in the first named company.

Dunkirk & Fredonia (Electric).—See Buffalo & Lake Erie Traction.

Great Northern.—The shares, each representing one-1,500,000th part of the beneficial interest in the trust created to hold the Great Northern ore properties, have been quoted at from 88 to as low as 79½. (Nov. 23, p. 146.)

Gulf & Interstate.—See Gulf, Colorado & Santa Fe.

Gulf, Colorado & Santa Fe.—Notice has been given as required by law that application will be made to the Texas legislature to consolidate the Gulf, Colorado & Santa Fe, which has 1,473 miles of line, the Texas & Gulf, which runs from Longview to Timpson, 71 miles, the Gulf & Inter-State, which has a line from Beaumont to Port Bolivar, opposite Galveston, 85 miles, and the Gulf, Beaumont & Kansas City and Gulf, Beaumont and Great Northern, two projected railroads. Permission is asked to build a 15-mile connecting line to Timpson and a line from the other (northern) end of the Texas & Gulf at Longview to a point on the Red River, 125 miles, this line to be extended northwest from the Red river through Indian Territory to connection with the Atchison, Topeka & Santa Fe, 150 miles. This announcement confirms the reported purchase of the Gulf & Inter-State.

Indianapolis & Louisville.—See Chicago, Indianapolis & Louisville.

Inland Empire.—See Spokane & Inland.

Macon, Dublin & Savannah.—A meeting of the stockholders has been called for December 2 to vote on an issue of $1,880,000 improvement and consolidated mortgage bonds, the profits of which are to be used to retire all outstanding indebtedness, and also to pay for betterments. All the stock and bonds of the company are owned by Atlantic Coast Line interests.

Peoria & Pekin Terminal.—See Peoria Railway Terminal.

Peoria Railway Terminal.—Under this name a company has been incorporated in Illinois with $1,000,000 capital stock as a successor, it is believed, to the Peoria & Pekin Terminal, which is to be sold soon under foreclosure. (Nov. 9, p. 130.)

Spokane & Inland (Electric).—This is the new name of the Inland Empire, which was a consolidation of four electric roads and a power company in and near Spokane, Wash., operating about 100 miles of road, and building about 75 miles more. E. H. Rollins & Sons, Boston, are offering at 100 and interest $2,743,000 first and refunding mortgage 5 per cent. bonds of the new company, being part of an authorized issue of $15,000,000; the rest is reserved to retire prior liens, to pay for the power plant mentioned above, and for future permanent extensions and additions.

Texas & Gulf.—See Gulf, Colorado & Santa Fe.

Union Pacific.—The annual report of the Union Pacific covering the operations of the year ended June 30, 1906, was made public on November 27. It shows surprising increases, particularly as they follow two record-breaking years. Gross transportation earnings were $67,281,543, an increase of $7,956,594 over 1905. Operating expenses and taxes, which include $2,200,000, charged as a reserve fund for maintenance, renewals, etc., increased by $5,101,059, leaving net earnings, after operating expenses and taxes, of $30,317,769, a gain of $2,855,539. Other income amounted to $10,329,816, larger by $3,833,056 than in 1905, while fixed charges were smaller by $2,290,575 than in that year. The surplus available for payments on the common stock was $27,782,642, or about 14 per cent., a gain of $8,979,945 over the previous year, and there was an increase nearly as large in the amount of common stock dividends. The company still holds about 20,000 shares of the 29,868 shares of Great Northern and 24,000 shares of the 38,877 Northern Pacific shares, which it received in exchange for its Northern Securities stock. The operations in these stocks are described as follows in the report:

"In exchange for 100,000 shares of the stock of the Northern Securities Company there were received 29,868.3 shares of the preferred stock of the Great Northern Railway Company, 38,877.3 shares of the common stock of the Northern Pacific Railway Company and 1,000 shares of the Northern Securities Company stubs. Under the subscription rights given to the stockholders of the Great Northern Railway Company, the Oregon Short Line Railroad Company acquired 37,444 shares of the preferred stock of said company.

"There were sold during the year stock of the Northern Securities Company to the amount of $2,850,000 par value; preferred stock of the Great Northern Railway Company to the amount of $9,960,089.49 par value; common stock of the Northern Pacific Railway Company to the amount of $14,830,082.15 par value, and stubs of the Northern Securities Company to the amount of $18.71 par value. The amounts realized from the sale of these stocks were credited against the cost of the stocks owned; the proceeds therefrom were used in the construction and acquisition of new lines, and in the purchase of equipment and other property; also in an increase in cash assets, which, since the close of the fiscal year, has been applied to the construction of new lines and to the acquisition of other property. The current and other free assets increased $71,354,759.20 over the preceding year.

"The stocks and bonds owned stand charged at the close of the year with $96,781,806.06, against $159,275,326.24 at the close of last year, a decrease of $62,493,520.18, mainly the result of the above-mentioned sales."

Including an extra $4,000,000 to be received as a full year's dividends on the common stock of the Southern Pacific owned and the amount charged to operating expenses for extraordinary improvement reserve and other equities, the surplus available for the common stock is equal to 20 per cent. Of the 10 per cent. annual dividends now paid, 6 per cent. is from railroad earnings and 4 per cent. from income from investments.